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ASPECTS OF RECONSTRUCTION—II

A SPECIAL committee of the Town Planning Institute has been investigating the problem of compensation and betterment in relation to town planning*. A review of existing legislation on compensation and betterment and the acquisition of land by public authorities, including a survey of foreign practice, satisfied the Committee that essential planning, and particularly replanning, cannot be carried out effectively under the existing legislation, nor under any development of a system which involves the separate assessment of compensation and betterment in respect to each individual interest.

This Committee does not find that existing legislation is, in general, unjust to either private or public interests, although it recommends certain amendments which should mitigate some existing anomalies. The chief obstacle to the achievement of positive results by statutory planning is the multiplicity and variety of interests that hamper it on all sides, each of which has to be separately valued and taken into account. Consequently, where private ownerships present an obstacle to securing planned development, redevelopment or conservation on an economical basis, essential simplification and equity are likely to be best achieved by the wholesale purchase of areas by planning authorities. To facilitate this, the Committee recommends an amendment to the Town and Country Planning Act, giving powers to authorities to buy land required "for securing the preservation of existing buildings or other objects of architectural, historic or artistic interest or for the protection or improvement of agriculture". It is pointed out how essential it is that all publicly owned land should be subject to planning control under town and country planning schemes, and recommends that all land in the country should be planned and valued by one authority, on uniform principles and at one time, at intervals, for example, of five years, thus affording a datum time for the assessment of compensation or betterment.

These recommendations, the Committee considers, would secure rural preservation on a sound and fair economic basis, and check extravagant claims for schemes for the redevelopment of developed areas. It urges that creation of a National Planning Board with vested interests in development rights would be fatal, unless such rights were subject to planning control. It also recommends that land developers should be required, without compensation, to allocate not more than 35 per cent of the land for streets and open spaces, or instead to make a cash payment, such money to be used by the planning authority to provide open spaces in or adjacent to the land.

The Committee considers that mineral working is at present amply protected by the Town and Country Planning Act, but it strongly recommends that the owner should not be allowed to have the best of both worlds, but should be required to choose between mineral value and building value. It also proposes an amendment to secure that when surface minerals have been exploited no building value shall attach to the land, which will in consequence be available for open-space uses or for agriculture or afforestation at a value which makes such uses possible. It recommends the abolition of the disparity between compensation and betterment, and urges that the problem of the future will be to cope with the migration of population, not with its increase. The foundation of satellite towns would involve the occupation of compact areas of rural land, but in that case enough

*Town and Country Planning: Compensation and Betterment. Pp. 60. (Town Planning Institute, 11 Arundel Street, London, W.C.2).

land should be purchased for the town and its agricultural belt, so that the question of claims for betterment would not arise.

The announcement that the Ministry of Works and Building has already set up an expert committee under Mr. Justice Uthwatt to examine the question of compensation and the recovery of betterment indicates that Lord Reith is already taking steps to deal with these problems. There is, in fact, already a wealth of material available for the assistance of the Minister of Works and Building, but even the most urgent demands for rebuilding require study and must conform to some plan if opportunities are not to be lost and fresh obstacles placed in the way of building more fitting and dignified cities where destruction has been concentrated. Unless at least the principles and outlines of an adequate plan are rapidly determined, there is grave danger that the necessity of physical rebuilding may in places jeopardize local if not national plans.

Scarcely less urgent are the second broad group of problems of reconstruction—what may be termed the rehabilitation problems. We shall be faced with the demobilization of large numbers of those in the armed and auxiliary forces and their return to peace-time employments. Industries that have swollen during the War to gigantic proportions will require relief from the troubles that may follow from surplus capacity. There will be other industries, which have had to close down during the War, to be restored to profitability. It would be optimistic indeed to assume that there will not be a new crop of depressed industries requiring care. Only foresight and careful investigation now can avoid severe dislocation and hardship when we begin to make the change-over from war to peace production.

There is no reason to be unduly pessimistic about our ability to surmount the difficulties with more success than last time, if forethought is given to the problems. The decline in our export trade, for example, which was such a stubborn element in our economic readjustment after 1918, is unlikely, in view of the much smaller part of export in our total economy to-day, to have the same effect on our general prosperity, even if it suffers as much. Moreover, we have advanced further in control of the trade cycle than we had in 1919. If we have a plan of campaign, we have a chance to control the post-War slump.

Overlapping with the remobilization of all our energies for the purposes of peaceful progress and orderly development are the problems involved in developing a new economic order and eliminating the frustration which has been responsible for the conditions leading up to the War, and removing the weaknesses which war has revealed. The development of our educational system and social services, the intensification of the attack on malnutrition and disease, the elimination of ugliness in our towns and replacement of the hovels that remain by worthy homes, demand creative thought as well as courage and determination to overcome whatever obstacles prejudice, vested interests, shortsightedness or ignorance may put in the way.

Success of such a policy and measures involves the fearless acceptance of the lessons of the War. No community can be exposed to such a strain as modern warfare imposes without some weaknesses in structure or organization being exposed. Underlying the concern which has recently been expressed at the position of war-production is a growing realization of how completely unprepared for war our industry was, how grave a handicap we must always labour under if, after every war, we show such complete confidence in eternal peace. Whatever the size of the standing forces we find it advisable to maintain after the present War, we shall be blind indeed to the lessons of 1936–40 if we do not maintain an embryo of munition industries, capable of rapid expansion, if we do not give all our citizens a minimum of training in their war-time duties, and if we do not make certain that stocks of the essential materials, adequately protected, are always kept in Great Britain.

A further weakness which the War has revealed is the apparent failure to train up a sufficient supply of men of ability to lead the nation. The courage, skill and character of such sections of the nation as the pilots of the Royal Air Force suggest the question whether our peace-time social structure really takes the advantage it might of such men. The lack of ability at the top may be due to some defect or bottleneck in the system of selection, and our educational system must be overhauled from the social point of view to determine whether it is at fault not so much on the pedagogical as on the social side.

Along with educational policy and system, national industrial policy requires overhaul. We have slipped from a *laisser-faire* system into one of State-encouraged cartels, not from deliberate choice but in a fit of absentmindedness. The process has been accentuated during the War by the policy of selecting the controllers, and economic

reconstruction will be impossible unless we first examine the system to determine whether it is united to achieve that combination of progress with security that should be the economic objective of a dynamic democracy. If we are on the wrong road, the demobilization of war-time controls will offer us our last chance to change course.

These are only some of the major questions which the stress and strain of war have brought before us and to which answers are being urgently demanded. There are many others—the wide field of building the nation's health, the readjustment of town and country life, especially for children, forced upon us by evacuation, and the new conception of colonial responsibilities to which the White Paper of a year ago gave expression. Here will be found the fields for Mr. Greenwood to plan in advance, as Mr. Churchill said in the recent debate, "a number of large practical steps which it is indispensable to take if our society is to move forward". The immensity of the task should be an inspiration and not a deterrent. The intensity of our concentration at the moment on the full utilization and proper distribution of the powers of production is providing us with the power to realize such plans when hostilities terminate. The expansion of industry dictated by the requirements of war is already, by the problems it creates, shaping the plan of future reconstruction. If that plan is worked out and set in motion, it will eventually, with the minimum of friction and delay, absorb the resources of production which will be released when the War comes to an end.

If therefore the call is to hard thinking and concrete planning, to the devising of appropriate machinery, drawing on the widest and wisest experience and ablest minds of the nation, it is equally one to co-operation. Mr. Churchill's plea for a continuance of national and political unity during the period immediately after the War is a sign that the Government is thinking ahead. Already it is becoming widely realized that the end of the War will be a signal, not to return to idleness and complacency, but to undertake great things. If that call is heeded, if professional men unite to bring a spirit of disinterested service, impartial inquiry and constructive thought into all those fields where their special knowledge or experience is of service, we need not despair of our ability to relieve distress and bridge the gap between war and peace, and to organize that full employment of resources which can both repair the ravages of war and usher in an ampler and nobler world order worthy of the sacrifices now being made.

RELATIONSHIP OF PURE AND APPLIED BIOLOGY

THE great number and the immediacy of applied biological problems in this time of war, coupled with the embarrassingly small use made of pure biologists by those in authority, has raised acutely the problem of the relationship of pure and applied biology*. To a certain extent academic botanists and zoologists are themselves to blame for their apparent uselessness, since for long they have tended to hold themselves aloof from applied work and have, indeed, sometimes decried not only its intellectual status but even its scientific value.

This superficial and arbitrary division of biology into 'pure' and 'applied' is a very unfortunate development of comparatively recent times. For Robert Boyle, true science was such knowledge "as hath a tendency to use", and for Francis Bacon "such philosophy as . . . shall be operative to the endowment and betterment of man's life". So recently as the days of Pasteur there was neither 'pure' nor 'applied'; there was simply biology, botanists and zoologists increasing knowledge and adding to the sum of human welfare. But in the thirty years or so overlapping the birth of this century, a series of trends and conditions, which in themselves make a fascinating history, led to the professionalization of biology; by the early 1900's most university professors had become 'pure' biologists, and by the 1920's they had become narrow specialists in one or another branch of pure biology. Such a condition was, clearly, far from satisfactory.

So artificial, so one-sided and extreme was this development, that it stimulated a reactive movement. In 1904 the Association of Applied Bio-

* Discussed at a joint meeting of the Association of Applied Biologists and the Society for Experimental Biology on Friday, March 28, 1941. The opening addresses were given by Prof. P. A. Buxton and Prof. W. B. Brierley. See also pp. 436 and 439 of this issue.

logists was founded, and although of small numbers and living a somewhat precarious existence in its early years, it survived to become the focus of a great development of application and research. In 1914 it established the *Annals of Applied Biology*. In 1909 the Development Fund Act was passed, and during the next fifteen years practically the whole of our present organization for applied biological research and the application of biological knowledge came into being. But the enormous growth and the very success of this organization, its wide range and the scale of its activities, only accentuated the distinction between pure and applied biology. The pure workers, fearful lest these Goths and Vandals storm their scholastic defences, or even absorb them, tended to shut themselves up like beleaguered garrisons within their ivory towers, and to develop a specialized and self-justificatory life of their own remote from the moil and toil of common life. So, to-day, there are the pure biologists holding the academic posts, and the others, the applied biologists, holding posts ranging from research institutes to commercial firms. Research institutes may be attached to universities, but, even so, their staffs are often regarded as slightly tainted.

The whole gamut of appointments from research institutes to industry is, of course, staffed by men and women trained in the universities. But, unfortunately, this is a one-way traffic system, and only in the rarest cases is there appointment of men from the applied side to the university staffs. During the last ten years the number of men who have returned to the fold can almost be counted on one hand. So, again the credo of academic men is accentuated, that they are the fount and inspiration not only of all knowledge but also of all application. As, year by year, successive vintages of students are conditioned to this belief by their academic teachers, by their academic curricula, and by every academic influence in a most formative period of their lives, so this myth lives on, rarely questioned. Occasionally, a mouse-like squeak of dissent arises, but the state of academic auto-hypnosis is little disturbed. In this connexion, academic authorities might well consider overhauling their system of appointments committees. Too often, at any rate, in the case of biology, those appointed to consider applications for academic posts are out of the field of modern research and biological advancement and should not, therefore, be put in the all-important position of deciding the future policy of biological teaching and research through their choice of candidate. It would be a decided advantage if applied research, in the form of a biologist or biologists from an industrial or agricultural institute, were more fully represented on those committees appointed to settle appointments to senior academic positions.

Now the danger of this situation is that there is no reciprocal fertilization: applied biology receives stimulus and inspiration from research in pure biology, but the academic workers not only shut themselves off from any reverse stimulus and inspiration, but often actually seem to take pride in their isolation, a state of folly that the most casual reading of the history of science should expose. Yet their almost pathological fear of the tainting or even absorption of pure science by applied science colours their vision: they feel themselves to be crusaders defending the sanctity of pure science, which for them possesses almost a mystical quality.

The psychological motivations in this situation are fairly clear, but its immediate practical importance lies in its repercussions, the influence this situation must have on biology as a scientific discipline, on biology as a vocational training for teaching, for agriculture and horticulture, for industry and commerce, on biology as an avenue for the intellectual development of the individual, and on biology as a primary constructive factor in social life and the progress of civilization. What all biologists would deplore is that pure biology, defending its virginity, should lapse into barren spinsterhood.

A question very ripe for the asking is whether this dichotomy or antithesis of pure and applied biology serves any good purpose, or whether, recognizing its falsity, it is not imperative to attempt a reconstruction and unification of the science. Certainly if our scientific societies and our scientific journals were reconstructed and unified, we should all be very much better off financially, there would be an enormous saving of time and energy, and scientific publication and the professional organization of biology could be enormously improved. From the point of view of the research development of the subject the advantages of such a unification of the pure and applied aspects are obvious. Such a unification does not, of course, imply that the economic biologist should immediately investigate fundamental problems, or that the theoretical biologist should undertake a modicum of commercial

practice. It does, however, imply, especially on the part of the pure biologist, very much more give and take, much more understanding and sympathy, and a greater exercise of imagination in his contacts with mother earth. It would, for example, be perfectly simple to arrange exchange appointments or periods of service between members of university staffs and those of research institutes, or one or another existing applied biological organization. The cross fertilizing influence of such interchange on both teaching and research would be immense.

It further implies that the academic curricula and system of training should not be regarded solely as a logical discipline, justified purely by intellectual criteria, but that attention should equally be given to biology as a factor in cultural and social life. A university degree in botany or zoology should not only be the hallmark of a competent botanist or zoologist, but it should also be the hallmark of an educated man, one capable of visualizing his biology not only as a logical system in a perspective of scientific values, but also as a means towards a fuller life in a more richly endowed social community. Pure science, guiding the student to a logical intellectualist ideal, leaves him facing the mental apparatus and not the concrete problems of life as life is lived in the world in his time. Biological teaching is only adequate when it brings biology into relation with everyday life. Biology for the biologist is totally objectionable; biological results show their highest value by becoming the property of the people. Our traditional methods of biological education are, at best, too much occupied with intellectual analysis, at worst, too much occupied with the acquirement of formularized information; we emphasize abstract formulations and neglect their wider human applications. Praiseworthy efforts to change this are now being made by the British Social Hygiene Council, especially through its Educational Advisory Board.

Applied biology is an integral part of the vital thought and culture of our age and, as such, must be incorporated in any constructive system of higher education. The way to accomplish this is not by the insertion of so many additional courses on the several aspects of applied biology into an already overladen curriculum: students already suffer not only from intellectual strabismus, but also from chronic mental indigestion. An infinitely better way, perhaps the only satisfactory way, is to effect a thorough reconstruction of our curricula, simplifying, condensing, and pruning, eliminating all the venerable accumulations, the merely traditionalist and sentimental moieties, the moribund and dead matter, the intellectual vested interests, the fetishes and shibboleths, exercising the most stringent selection, and balancing them throughout with a more luminous vision and a more prospective imagination. For more than a generation biological teaching has been strung along the threads of logical evolutionary principles, but it should be patterned as a fabric of which the warp is the principles of logic and the woof the humane relationships of biology.

It is usually objected that all biologists, but perhaps more especially those whose leaning is towards application, must be given "a sound fundamental training", and it is always assumed that this is given by our present system. Whether this system is the only one which can do this, whether, indeed, it is the best system for this purpose, is never raised in question. Now all biologists, pure and applied, will agree that in his training a student should attain certain values, and these values are what is usually implied when the phrase "sound fundamental training" is used. But are these values anything more than the acquirement of the scientific outlook and attitude, familiarity with scientific methodology and technique, knowledge of analytic data within a recognized field and capacity to evaluate such data, and appreciation of logical scientific principles with facility in their exemplification? Does a "sound fundamental training" imply more than this and, if not, cannot these values be achieved better from biology presented as a unified and patterned fabric of development than from biology presented purely as a logical system in the traditionalist way?

Life is wider than logic, and no scientific system is sufficient unto itself. We want our students to be not merely experts in some particular branch of science, but also experts in the art and understanding of life. The improvement of natural knowledge for use is a duty as instant as that of improving natural knowledge for discovery. Science is not merely a channel of escape to a private and self-sufficient world, to be justified by remote and abstract criteria; science is a social function, with social roots and social consequences, and if our science, if biology, is to live on as a vital human force, it must ever keep essential human values in view, and it must justify its existence in the world by its contributions to it.

FERTILITY, GROWTH AND BREEDING OF FARM ANIMALS

Farm Animals:
their Breeding, Growth and Inheritance. By Dr. John Hammond. Pp. viii+199. (London: Edward Arnold and Co., 1940.) 14*s*. net.

AMONG the authors of recent texts on animal breeding, there are no armchair philosophers who, retiring from active research, have time to write a comprehensive and well-balanced treatment of the whole subject. In the distant future, it is to be hoped, Dr. Hammond will fill this rôle. Meanwhile he has provided a short account of his more immediate interests in the form of two series of lectures—the one on fertility and growth and the other on genetics in relation to the practical problems of breeding farm animals. Were it not for the second and shorter part, the contents might well be described as a résumé of recent Cambridge experiments on fertility and growth. Problems of fertility, artificial insemination and proportional growth in all the main classes of farm livestock have been discussed in the light of research which Dr. Hammond has himself carried out or inspired. The work on fertility has given promise of greater breeding efficiency, particularly in horses, which are notoriously unreliable. Besides a very clear and concise account of the ordinary processes of reproduction and the diagnosis of pregnancy, there are hints of future developments in hormone therapy. The possibilities with sheep in this direction are notable since they include raising, where desired, the numbers of lambs born, and extending the mating season. Closely linked with the subject of fertility, of course, is that of artificial insemination, the most effective use of which presupposes a thorough understanding of the natural process. No attempt has been made to advocate artificial insemination on a grand scale, but those whose special circumstances require it will find here much good practical instruction.

The economic pressure which has focused attention on the question of quality in meat will be familiar to most readers. Equally familiar no doubt will be the fruits of Dr. Hammond's efforts in this field. Here, in small compass, is developed the principle that changes in the proportions of the organs and tissues follow a definite course during growth. It is further shown that this course, and therefore carcass quality, can be modified by either raising or lowering the plane of nutrition. By implication, the right weight at which meat animals should be slaughtered and the appropriate rates of live-weight gain at various stages of growth can be determined. Just how much control can be usefully exercised without conflicting with other considerations, such as the periodic nature of the supply of certain feeding stuffs, or the varying response of different individuals to the same treatment, is unfortunately not yet clear. Rapid growth-rate up to weaning time, however, is usually desirable, and this is in line with the advantages of improving intra-uterine nutrition and milk production.

The second part of the book will interest geneticists because Dr. Hammond holds independent views on certain aspects of heredity. He suggests repeatedly, for example, that genes may be classified either as unit factors governing the appearance of fancy points or deleterious recessives, or as multiple factors which control variation in quantitative characters and tend to be dominant. The impression is given that mutations affect mainly the unit factors, and are nearly always worthless. Even the polled character is doubtful, since on p. 135 it is not mentioned as having any semblance of real economic value, whereas on p. 149 it is pointed out that there is a need for a polled Shorthorn breed to save a lot of time and money now spent on dehorning beef cattle. While no one is likely to deny that the bulk of obvious mutations are useless to the breeder of commercial stock, such a simple classification of genes will be questioned. Furthermore, it is very doubtful whether there are any basic distinctions yet to be drawn regarding their behaviour in mutation or development.

These innovations might have been more impressive if they had not been accompanied by a number of dubious examples of the workings of heredity. Hernia in pigs, for example, is conveniently assumed to be a simple recessive (p. 146) although it is by no means certain that multiple factors are not involved. Again, on p. 142, grey colour is referred to as dominant to bay in horses although the genes concerned are not alleles; on p. 171, the sire and dam together are said to contribute half the germplasm to the offspring instead of half each, thus confusing the conception of parent-offspring correlation; and on p. 150, five generations of backcrossing are regarded as sufficient to achieve the transfer of a single gene from one breed to another, which is an over-simplification. Such inaccuracies, like the rather plentiful printing errors, might be accounted for by limitations of time or space. But underlying the more substantial departures from current genetic theory

has been the feeling that random mutations are inadequate to account for the progress in livestock breeding, although in respect of conformation that progress is shown to be actually a hastening of the tempo of evolutionary trends. The creation of improved environments is therefore supposed to have a directive influence on the mutation of genes affecting productive qualities (but not of unit factor genes)—which recalls Lyssenko's attitude.

Many readers will still feel disinclined to discard the more orthodox theory of evolution, even for farm animals, until forced to by weight of evidence. The further contention that selection, to be effective, should be practised under the most favourable environmental conditions, although widely supported, is often misleading. Selection *under* these conditions is selection *for* them. The unqualified idea that the resulting animals can then be used readymade elsewhere appeals, just as something for nothing always does. Yet surely they can be used successfully for grading up poorer stock only at a price which may be the preliminary grading up of the environment, lowered carrying capacity, or reduced hardiness.

Fundamentally, however, Dr. Hammond's philosophy is very wise. As fast as environment can be improved, animals able to make the best use of it should be bred. Unhappily, livestock improvement often lacks impetus and guidance, and awaits the establishment of some practical means of short-circuiting the wearisome piling up of performance records. To that end, Dr. Hammond has rendered great service by clarifying obscure problems, and giving more specific direction to breeding efforts.

H. P. DONALD.

METABOLISM OF INORGANIC SUBSTANCES

Mineral Metabolism

By Dr. Alfred T. Shohl. (American Chemical Society Monograph Series, No. 82.) Pp. x+384. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1939.) 30*s*. net.

THE excitement of the race to establish the formulæ of vitamins has diverted interest from other branches of the science of nutrition; but now that so many vitamins have been synthesized, attention is turning more and more to the study of the metabolism of inorganic substances. Many elements are essential for growth, and, in a number of cases, the quantities required are no larger than the quantities of vitamins required, but there are still many obvious gaps in our knowledge of their action. The experimental methods developed for the study of vitamins may be applied to the study of mineral metabolism, but the practical problems are different; the isolation of the active principle, so important in the case of vitamins, is no problem at all, and the main initial difficulty is to devise diets from which the active principle is absent.

The appearance of an authoritative monograph on mineral metabolism will be widely welcomed. It contains as much information per page as anyone could wish, but it is not merely a catalogue of results, nor a summary of the opinions of others. It is a balanced review of the work done up to 1938. The bibliography, which contains about 1,200 references, is not intended to be exhaustive, and may, in certain cases, cause irritation by failing to give due credit to the first discoverer of new facts, but it will certainly enable anyone to obtain access to the literature.

Successive chapters are devoted to the mineral composition of the body, secretions and excretions, internal secretions, total base, chloride, ammonium and bicarbonate, calcium and magnesium, phosphorus, sulphur, iron, iodine, traces, water metabolism, anion-cation relationships, and mineral intakes, balances and requirements.

The field is a wide one, and is not all covered with equal thoroughness. Potassium, for example, receives less attention than many would like to see accorded to it, while calcium and phosphorus are more fully discussed.

Everyone will find in this book much that is interesting and stimulating. Among the elements on which attention has been focused in recent years are bromine, manganese, silicon, copper and zinc, all of which are normal constituents of animal tissues. Bromine has been found in particularly high concentrations in the anterior lobe of the pituitary gland; deficiency is said to cause death in the second generation of rats. The view that chloride and bromide are interchangeable in metabolism is rejected. Deficiency of manganese causes effects not unlike those of deficiency of vitamin E; male rats lose the use of their testes, and female rats produce young which do not survive. Both copper and cobalt play an important part in the formation of red blood corpuscles. Dr. Shohl's conclusion that zinc is an essential element has, of course, since been confirmed and explained by the discovery of its presence in carbonic anhydrase; which will add to the interest of experiments on deficiency of this element.

The publication of this book will help to stimulate work in fields where there is still much to discover.

J. H. GADDUM.

SCIENCE AND THE NATIONAL EFFORT*

BY THE RIGHT HON. LORD HANKEY, P.C., G.C.B., G.C.M.G., G.C.V.O.

THE present position of scientific help in the prosecution of the War has been built up on foundations well and truly laid before war broke out, when the three great pillars of the permanent civil research organization of the Government were the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council.

Similarly, on the defence side there were important research organizations in the Admiralty; the Ministry of Supply, which undertakes most of the research work for the War Office; the Air Ministry, which, however, has now handed over most of its research work to the Ministry of Aircraft Production; and the Ministry of Home Security, which occupies a position intermediate between the Service Departments and the Civil Departments. In addition there was a good deal of research in the Civil Departments.

Just six months ago, with the approval of the Prime Minister, the late Mr. Neville Chamberlain, as Lord President of the Council, set up a Scientific Advisory Committee. It was the last official act of his long career. He had given much thought to the subject and when I last saw him he spoke of it with infectious enthusiasm: a characteristic instance of his far-sighted statesmanship. I am now drawing on my six months' experience as chairman of the new Committee. I had better begin by explaining its status. Besides the chairman, the Committee consists of Sir Henry Dale (the president of the Royal Society), Prof. A. V. Hill, M.P., and Prof. A. C. G. Egerton (joint secretaries of the Royal Society), together with the secretaries of the Department of Scientific and Industrial Research (Sir Edward Appleton), the Medical Research Council (Sir Edward Mellanby), and the Agricultural Research Council (Sir Edwin Butler, who unfortunately had to resign on grounds of ill-health); the chairman of the latter Council, however, Sir Thomas Middleton, has attended many of the Committee's meetings. In addition, at the request of the Committee, the Lord President of the Council invited Sir William Bragg, the former president of the Royal Society, whose term of office expired shortly after the formation of the Committee, to serve as an additional member until he had completed a period of twelve months. The joint secretaries are Prof. W. W. C. Topley, a distinguished fellow of the Royal Society, with a colleague from the offices of the War Cabinet.

The Committee is in touch through the Royal Society with the great streams of scientific research and development; through the representatives of Government research with Government activities; and through the chairman and the Lord President, to whom the Committee reports, with the policy of the Government in these matters.

The question has been raised whether in constituting this Committee the Government has interpreted the term 'scientist' too narrowly. The reason for not including representatives of applied science was not a failure to appreciate its great importance to our war effort, but simply that the proposal did not fit into the Government's conception of the Scientific Advisory Committee. The Government had envisaged a small body with contacts with the whole of science, but not representing any particular section, to ensure the utmost use of science and men of science in the prosecution of the War. The representation of applied science with its many branches must have involved some enlargement of the Committee and would have altered the whole plan. The Government, however, is at present in touch with the professional societies concerned with a view to the possible establishment of a separate organization working in the field of applied science and in close touch with the Scientific Advisory Committee, and an announcement may be expected before long.

The Committee has devoted itself mainly to the contribution of science in the war and will continue to do so. Nevertheless, the importance of the eventual use of science in problems of reconstruction has not been overlooked, and the Committee is in touch with the Minister without Portfolio, who is in charge of these matters.

At its first meeting the Committee decided to prepare as a background for future work a survey of the scientific activities of Government Departments.

In addition to obtaining written reports, the directors of scientific research of each of the Departments engaged mainly in war work were invited in turn to tell the Committee something of their activities. Sometimes they were accompanied by staff officers of the Fighting Services, as representing the users of research.

* From a statement before the House of Lords on April 2.

Owing to their secrecy, some of the subjects of discussion have to be confined to the smallest possible circle. To provide for this the Committee appointed a small Defence Services Panel composed of members who were already associated officially with secret Government research work.

In describing how far the assistance of men of science has been enlisted in the prosecution of the war, I shall return for a moment to what I called "the three great pillars of the permanent civil research organisations".

Thus the Department of Scientific and Industrial Research with its thirty-three advisory boards or committees, each dealing with a particular subject and each commanding the services of distinguished experts, disposes of a wealth of scientific talent. Their membership includes fifty-one fellows of the Royal Society. In addition, eleven members of the staff of the Department of Scientific and Industrial Research are fellows of the Royal Society. Eight fellows or university professors are retained as consultants, and fifteen university professors are engaged on extra-mural contracts in their own laboratories.

The ten Research Institutes for which the Department is responsible include the National Physical Laboratory, the Chemical Research Laboratory, and Laboratories or Stations for research on Building, Food Investigation, Fuel, Roads, Forest Products, Water Pollution and Pest Infestation. These, with the Geological Survey of Great Britain, provide facilities of immense importance to our war effort.

The Department renders assistance to the Fighting Services and to practically every Government Department; for example, in home security problems, such as building and shelter construction and bomb disposal, and to the Ministry of Food in food storage, by combating pests and devising economical methods of packing to save space. Geology, among other contributions to our war effort, has informed authorities as to where sand is to be found in urban areas, thus saving transportation and cost.

Similarly the Medical Research Council, with its forty-five committees or sub-committees, its National Institute for Medical Research, its nine smaller research units, and its connexions with research in universities and elsewhere, is doing much to help our war effort. For example, in concert with the Ministry of Health and other Departments concerned, preparations were made before, and expanded during the War, with the view of safeguarding public health against risks arising from war conditions, such as concentrations of transferred populations in some districts, to say nothing of the effects of enemy action. An Emergency Public Health Laboratory Service was established with laboratories all over the country so that any unusual outbreaks of disease might be rapidly identified. Stocks of anti-sera and vaccines were accumulated and distributed throughout the country.

In a speech in this House in July 1939, I mentioned that the application of research in nutrition usually lagged some fifteen years behind discovery. This is no longer true. Under pressure of war conditions results of research are being applied in many directions. The Food Policy Committee of the War Cabinet makes good use of a Scientific Advisory Committee, and the Ministry of Food has a technical advisory staff.

The sphere of the Medical Research Council extends far beyond 'medicine' as this term is generally understood. It is concerned in all problems that affect man's health and efficiency. This enables the Council to assist the Defence Departments in problems relating to personnel and the use of science for increasing the efficiency and well-being of the men who have to operate machines such as aircraft, tanks and so forth. Excellent work of this kind has been done by a Flying Personnel Research Committee set up by the Air Ministry with the co-operation of the Medical Research Council nine months before the War.

The Scientific Advisory Committee has brought this aspect of science to the attention of the other Service Departments. The scope of the Flying Personnel Research Committee has now been expanded to cover naval personnel problems and a Military Personnel Research Committee has also been set up.

The Agricultural Research Council, with its twenty-five standing and technical committees of men of science with special experience of the matters with which they are concerned, with its Field Experimental Station, and with its great influence on the work of the twenty-three existing agricultural research institutes and other agricultural research subsidized by the Government, also makes an important contribution to our war effort.

I come now to the use of science in the military side of the war, where, as already mentioned, the Departments concerned are—the Admiralty; the Ministry of Supply; the Ministry of Aircraft Production, and the Ministry of Home Security.

There is much in common between the methods of research and development of these Departments. Each has a director of research. The Ministry of Supply and the Ministry of Home Security have Central Advisory Committees to assist the directors in planning and carrying out the programme of work. The three Defence Departments are represented on them and the Committees include

unofficial as well as official experts. The Ministry of Aircraft Production has an Aeronautical Research Committee, the successor of the Advisory Committee on Aeronautics established in 1909.

The First Lord of the Admiralty recently announced in another place that, in order to strengthen still further the co-operation between the Admiralty Research Department, outside scientific workers, and the Navy itself, the Board has decided to set up a Scientific Advisory Panel.

These Departments maintain research establishments, more than a score in number, all manned by highly qualified men of science. They work in close co-operation with one another, and one Defence Department will often refer a particular problem to an establishment maintained by another which has better facilities for the job. Each Department has frequent resort to the Department of Scientific and Industrial Research and the Medical Research Council, as well as to universities or other research institutes, or the research laboratories of producing firms. There is an increasing tendency to bring the large producing firms into co-operation at the earliest possible stage so that full advantage can be taken of their knowledge and experience.

I must also mention among Service research activities the Ordnance Board, which now acts under the Ministry of Supply. It is an inter-service body with executive functions as to trials and calculations concerning fire-arms, their equipment, ammunition and armour. The Board derives originally from the Committee of Field Officers and Artillery under the ægis of the Board of Ordnance, 1518. Its standing members are officers of the three Services, and distinguished men of science are appointed from time to time as associate members.

Civil Departments may be divided for our purposes into those responsible for research establishments or for experiments or tests, and those which are not. Those Civil Departments which have no research establishments of their own usually have scientific committees, and both categories make wide use of the facilities of the Department of Scientific and Industrial Research, the Medical Research Council and/or the Agricultural Research Council.

The main conclusions of the Scientific Advisory Committee from its survey are that the scientific activities of the Government are far more extensive and far more effective than is commonly realized, and that much of the criticism is due to lack of knowledge of the facts. For example, one criticism is that the Government has failed to make effective use of the services of outside men of science. The Committee does not think this criticism justified. The names of nearly three hundred senior men of science associated in scientific work on behalf of the Government have come to its notice. This figure does not include the large numbers of younger men of science engaged continuously on war work in the numerous research establishments maintained by the Government, or in the Services.

It would be too much to claim that the fullest use is being made of every senior scientific worker, but in the more important fields the majority of those especially well fitted to assist our war effort have been given an opportunity to do so. In some fields, however, opportunities may not yet have appeared, and the Committee reports that there has been a feeling of frustration among individuals. In the case of junior scientific workers the demand in different fields of science varies and fluctuates so widely that it is impossible, except very gradually, to absorb in work of national importance all those who are anxious to employ their special knowledge in some form of war activity. Some help, however, is afforded by training schemes whereby men of science trained in one subject, where opportunities for war service are few, can be given rapid training in an allied science.

Having recorded general satisfaction with the range and effectiveness of the Government's scientific activities, the Committee comments that some of the existing forms of organization have proved more effective than others. It directs attention to the effective and economical methods developed by the Department of Scientific and Industrial Research and the Medical Research Council, the success of which it believes is largely due to the fact that they have been allowed full scientific freedom and complete control over the funds at their disposal.

The Agricultural Research Council, as at present organized, has not the same freedom of initiative and action. Believing the scientific development of agriculture to be of the greatest importance to the country, both during and after the War, the Scientific Advisory Committee has considered how much freedom might be secured, and the Council's activities thus made more effective. In consultation with the Minister of Agriculture and Fisheries and the Secretary of State for Scotland, the Committee has drawn up proposals for strengthening fundamental research and ensuring a more ready application of promising scientific discoveries to agricultural practice (see p. 447 of this issue).

So far as the scientific activities of the Defence Services are concerned, the points to which the Committee attaches the greatest importance are the following :

(1) Provision in the organization of departmental scientific staffs for regular consultation

with a strong advisory council or committee which includes outside scientific experts.

(2) The utmost possible use of the facilities of the Department of Scientific and Industrial Research and the Medical Research Council. This is already in operation and is likely to be extended.

(3) A much wider and more intensive study of those problems connected with early and adequate provision for the efficiency of personnel in the design of new instruments of war.

(4) The close co-operation at every stage of research, development and production between the operational and scientific staffs.

I come now to one or two other matters that have engaged the attention of the Scientific Advisory Committee.

The Committee has suggested the names of men of science for particular tasks or to assist in specific investigations to a number of Government Departments, as well as to the British Council. In this connexion I must mention the invaluable work of the Central Register of the Ministry of Labour and National Service, for the utilization in Government Departments and elsewhere of persons with scientific, technical, professional and higher administrative qualifications. With the aid of the Government Departments concerned, and of various outside organizations including the Royal Society, and of a very strong advisory council, the register is very comprehensive.

The question of enlisting scientific researchers of other countries and refugee aliens has been raised. The Scientific Advisory Committee has given a good deal of attention to this question. It presents obvious difficulties. If, as I have said, we have not absorbed into the Government war effort all our own men of science, we cannot absorb unlimited numbers of refugee men of science. In addition, much of the research work is so secret that precautions have to be taken. Nevertheless, a number of refugee specialists are employed in research laboratories, mainly on the medical side so far as the Government is concerned, but also in industry.

Scientific co-operation with the Dominions, India and the Colonies is satisfactorily provided for. Canada, of course, occupies a position of special importance, and her collaboration in the scientific field is proving of the greatest value. There is also in Canada scope for close co-operation in scientific matters with the United States. Prof. R. H. Fowler has been in Canada for some eight months, and is now being relieved by Sir Lawrence Bragg—a colleague of equal distinction.

The Committee has also taken a deep interest in the question of co-operation in scientific matters with the United States. At an early meeting it discussed the matter with Prof. John Fulton of Yale University, who was on a visit to Great Britain on behalf of the U.S. National Research Council. A member of the Committee, Prof. A. V. Hill, had already been to the United States on a scientific liaison mission, and the Committee had discussions both with him and with Sir Henry Tizard, on his return from a similar mission.

After consideration of the Committee's proposals, and after consultations with the proper authorities in the United States, a comprehensive scheme has been put in operation.

His Majesty's Government has elected and sent Dr. C. G. Darwin, the director of the National Physical Laboratory, as director of a Central Scientific Office working under the direction of the British Supply Council in North America to collaborate with United States research bodies, to act as a channel for exchange with the appropriate United States authorities of technical and scientific information, and generally to co-ordinate scientific and technical inquiries to and from the United States authorities, except on those Service questions that are dealt with through the Service attachés. The scientific mission to Canada is closely linked with this system so as to ensure a complete interchange of scientific and technical information between the three countries.

At the same time President Roosevelt has sent to Great Britain Dr. J. B. Conant, president of Harvard University, to establish a corresponding mission in this country, and Dr. Conant and some of his colleagues have attended meetings of the Committee. This mission has received a very warm welcome, and arrangements have been made to facilitate its work. Its permanent secretary, Dr. Hovde, knows his way well here, for, as a Rhodes Scholar, he spent some years at Oxford. Accredited American men of science have already arrived in Great Britain.

The historians of war from the earliest time pay their tributes to the importance of science. The theme of a long chapter by Polybius on Archimedes is that "The genius of one man is more effective than any number whatsoever". In these days no one man, whatever his genius, can cover more than a fraction of the immense field of science in war, of which I have only been able to give the faintest impression in the time at my disposal. We require thousands of scientific workers.

We are engaged in a death struggle with an enemy who boasts, with justification, of his achievements in the field of science. Our men of science are at least as good as his, and with the aid of the scientific resources of the Empire, and especially of the Unites States, we are building a scientific equipment which is destined to play an ever-increasing part in our war effort and in the period of reconstruction that must come thereafter.

MALARIA IN WAR*

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THROUGHOUT the centuries of European history, from causes that are still subject to dispute, malaria has ebbed and flowed like a fatal tide[1]. During the nineteenth century the disease was in retreat and in 1914 seemed to be hanging on in only a few localities, mostly in the south-east corner. The War of 1914–18 changed all that. With the massing of troops unaccustomed to infection in malarious regions, malaria became rife among the combatant forces. With the return of these to their homes, and the interchanges of peoples which took place after the War, the disease revived among the civil population in all sorts of unexpected places: in the eastern half of England, the north coast of Germany, parts of Italy long free from malaria, up in the arctic at Archangel; while a terrible epidemic decimated vast areas of Russia.

That malaria would be important to the armies in Europe and elsewhere was foreseen by Laveran, Ross, Nocht, and a few other malariologists; but their warnings were unheeded. How important it proved may be judged from a few figures. In East Africa the average strength of Allied troops was about 50,000. Admissions for malaria in 1916 and 1917 have been estimated at 120,000. In Macedonia in 1916 the French could put into the field only 20,000 men out of a force at least six times this strength. On the same front the British had 30,000 men down with malaria in 1916, 70,000 in 1917. In 1918 more than two million service days were lost on account of malaria.

It is not my purpose, however, to review the whole subject of malaria in war (see Christophers[2]), but, as part of a discussion on the relation between pure and applied biology, to use the subject of malaria as a text from which to illustrate the ways in which pure biological research can help the practical man, and the almost greater frequency with which empirical results provide the starting point for fundamental work.

Let us first summarize the theories of malaria transmission as they are accepted to-day. Malaria is caused by Plasmodium, of which there are three or four species producing in man clinically different varieties of the disease. The sexual forms of the parasite mature and conjugate in the stomach of the mosquito, giving rise to numerous 'sporozoites' which invade the salivary glands and are injected into man when the mosquito feeds. This cycle takes place only in Anopheles. All the members of this genus, which contains some 150 species, are therefore potential carriers of malaria. But in fact relatively few of these species are important—indeed only a proportion of those which breed near human habitations and feed readily on man. In regions of endemic malaria, the local population, while harbouring plenty of malaria parasites, acquires a certain tolerance to the disease (the existence of a true immunity is a much debated question). Such people are the source of the infection which wreaks such havoc among unseasoned troops quartered in their midst.

To consider now the carriers of malaria in the areas of present or prospective hostilities. The chief carrier of malaria in Europe is *A. maculipennis*; a species which breeds in swamps and grassy pools and slowly flowing rivers. It is the species responsible in the Roman Campagna, and many other coastal regions of Italy, Sicily, and Sardinia; the carrier in the notorious Struma Valley in Macedonia, the low-lying parts of Albania and Greece, the coasts of the Black Sea.

Before the War of 1914–18, malaria in Europe was thought always to be associated with low-lying country of this type. It came as a complete surprise to find that malaria was often most intense in mountainous regions. The Germans discovered this in the Taurus of Anatolia, the Italians in southern Italy, the Allies in Palestine. In the eastern Mediterranean rain falls only in the winter. In the spring the streams from the mountains are raging torrents unsuited to mosquito larvæ; but as the summer advances these streams are reduced to broken pools or trickles among stones and provide the breeding places of *A. superpictus*, a species rendered all the more dangerous because during the summer the people concentrate around the few remaining sources of water.

Egypt has commonly been regarded as comparatively free from malaria—because it is not conspicuous in the large towns and military cantonments. But it has recently been realized that there is much malaria, carried probably by *A. pharoensis*, among the rice cultivators of the delta region.

Moving westward into the dry regions of North Africa one would expect malaria to be absent; and that is true enough of the open desert and of the coastal zone of Cyrenaica. But it is not true

* A paper forming part of a discussion on the "Relation between Pure and Applied Biology" held by the Association of Applied Biologists and the Society of Experimental Biology at the London School of Hygiene and Tropical Medicine on March 28, 1941.

of the oases. Jarabub and the other oases of the western desert, Kufra and other oases of Fezzan are all intensely malarious. The carrier species is not fully proved but is probably *A. multicolor*, a mosquito that thrives in brackish or highly saline water.

In the coastal belt of Tripolitania the situation is different. Here are streams running into the sea. These have been blocked by settlers to assist in irrigation. Swampy breeding places for *A. maculipennis* have thus been created, and recent years have seen a great increase in malaria.

In Africa south of the Sahara there are some thirty species of Anopheles but only two are really important. *A. gambiæ* is a ubiquitous species that breeds in rainwater puddles, borrow pits, river pools or quiet backwaters—any water freely exposed to sunlight. In dry regions like Somaliland its prevalence is related to local rainfall. It is the most dangerous Anopheline in the world—its introduction in 1932 from Dakar to Brazil is one of the major health disasters of recent times. It constitutes a threat to the southern parts of the United States, and has caused America to invoke the principle of 'hemisphere defence'. *A. funestus*, the other dangerous African species, is confined to the grassy edges of slowly flowing streams. Such waters are often perennial, so that this mosquito may keep malaria smouldering in a locality until local conditions of rainfall and temperature favour *A. gambiæ* and initiate an epidemic.

That is an over-simplified account of malaria transmission; and particularly so in regard to *A. maculipennis*. For the local abundance of this species bears no relation to the incidence of malaria in Europe. The current explanation of this phenomenon of 'anophelism without malaria' must, in the interests of brevity, be set forth dogmatically[1]. It is that the species *A. maculipennis* is made up of a number of biological races or varieties which differ in their habits and so in their capacity to convey malaria. Morphological differences between these races were at first sought in vain. Systematic entomology, which is often twitted for excessive zeal in subdividing species, proved too superficial for the task. Later such differences were found in the structure and pattern of the eggs. To take a few examples: race *messeæ* with richly patterned eggs and race *typicus* the eggs of which have two bars on a white field, breed in fresh inland waters; they feed almost exclusively on cattle and the chances of their taking the necessary two meals from man at the appropriate intervals are so remote that, with few exceptions, areas where these are the prevalent races are free from malaria. Race *labranchiæ*, with small egg floats and a more uniform pattern, is a brackish water breeder of the western Mediterranean (Italy, Sicily, North Africa). It is far more prone to bite man, and its prevalence is always associated with malaria. Race *elutus*, with no egg floats or pattern, is a brackish water breeder of the Balkans and the Near East. Precipitin tests on the blood in wild caught females have shown a preference for human blood; and wherever this race occurs it is a dangerous carrier. Race *atroparvus* is more puzzling. Its chief area of distribution is the Atlantic seaboard of Europe. In egg type and breeding habits it is allied to *labranchiæ*, but whereas in some localities it attacks man and conveys malaria, in others it seems to be diverted to cattle, and malaria is absent. Perhaps there are differences in the housing of man or animals which will account for this; perhaps there is not one *atroparvus* race but several.

In *atroparvus* regions (around Amsterdam for example) malaria is often a house disease. Instead of going into complete hibernation in the winter (as does *messeæ*, for example) *atroparvus* females will continue feeding and so transmitting malaria to the household. But they fail to develop their ovaries, so that they have no call to leave their resting places and fly afield. Here is an attractive problem, presumably of internal secretion[2], directly connected with the epidemiology of malaria.

What is the zoological status of these mosquito races? Here is a field crying out to be worked by geneticists; particularly geneticists prepared to study the genetics of *behaviour*—for it is the natural history and behaviour of these insects which are important from the malariologist's point of view. A little has been done by the malariologists themselves. Only the *atroparvus* male has so far been persuaded to mate in small cages. Crossed with females of the other races, varying degrees of infertility are revealed, lethality supervening at varying points. With *messeæ* most of the eggs are sterile; with *elutus* the larvæ die; with *typicus* sterile adults of both sexes result; with *labranchiæ* all the resulting females are normal but only a part of the males.

That being the malaria situation, what is the Army doing about it? The general plan (Perry, Manifold, *et al.*, see Christophers[3]) is to establish mobile malaria laboratories. These are commanded by officers with wide experience of malaria in the tropics; their commissioned staff includes malariologists and entomologists; the senior non-commissioned officers will be young graduates in biology or senior laboratory assistants. The function of these units will presumably be to instruct the field hygiene sections in general anti-malarial work; to provide all the necessary local information regarding the incidence of malaria in the local population, and the breeding places, habits and infectivity of the dangerous species;

and to advise on specific measures of prevention.

As an organization this seems well conceived. What it will achieve in practice must depend, as in all human enterprises, upon the abilities of the people doing the work. For there is no rule of thumb in malaria control; each problem is a local problem which must be approached with an open mind. It is where the malariologist has applied blindly, in a new locality, methods which he has found successful elsewhere, that the disasters have occurred which have brought the subject into disrepute.

The methods of malaria prevention still call for investigation. Of all the single measures, sleeping under a mosquito net is perhaps the most valuable. That should be practicable in base camps; but is it possible to devise a bivouac net for use by troops in the open and to persuade them to use it (see Manifold, *loc. cit.*[3])?

In the past, little value[3] has been attached to the destruction of adult mosquitoes; but where semi-hibernating *atroparvus* are the cause of malaria this is a most important measure. Under war conditions there may be times when it is the only practicable measure. It involves the whole subject of insecticidal sprays and the methods for dispersing them.

The abolition of breeding places is often an engineering problem of a special kind. The engineer must turn malariologist or vice versa; or the two must co-operate. That is a vast field beyond our scope. One form of engineering control consists in connecting the breeding places with the sea. What factors—water movement, predators, salinity—are here concerned would repay investigation.

Increasing use has been made recently of 'flushing' to control stream breeding mosquito larvæ[4]. Siphons are built into the stream which periodically release a large volume of water. It is believed that larvæ migrating to the margins of the stream are stranded as the flow subsides, but the question merits study.

The classical method of killing mosquito larvæ is by applying oil to the surface of the water. This does not, as is popularly supposed, suffocate the larvæ by preventing their breathing at the water surface. A little of the oil enters the tracheal system of the larva and the oil contains poisons which affect presumably the nervous system. A vast amount of empirical information exists on the preparation and application of oil mixtures, but exact knowledge is scanty. We know almost nothing about the toxic constituents of the oils used.

Oil is usually applied as a spray to form a layer 15–20 μ thick. Equal in importance with toxicity is the ability of the oil to form a stable film of this thickness on the water surface. As a result of an investigation financed by a group of oil companies and carried out at the London School of Hygiene and Tropical Medicine by D. R. P. Murray[5], some light has been thrown on this problem. If an oil contains polar substances such as naphthenic acid or long-chain fatty acids, with a strong tendency to form mono-molecular films on the water, these may spread out ahead of the oil, occupy the water surface, and force the main body of oil into lenses or droplets. Indeed, it has been observed in practice in Malaya that if the coolies waded in the water, an oil which previously spread might be prevented from doing so by oil films coming from their bodies[6]. Such resistance to spreading, or general instability in the oil film, may, however, be overcome by the presence in the oil of 'spreaders'. These are of unknown composition but include 'cracked spirit gum' (derived from polymerization of olefinic hydrocarbons), certain resins, and some constituents of petroleum residues, particularly the undistilled residues of aromatic concentrates. The efficiency of such 'spreaders' in a given oil may be gauged by the direct measurement of their spreading power against surface contamination in the Adam-Langmuir surface pressure trough.

The difficulties of this subject of oils are made greater by the fact that the experimental materials are largely of unknown composition. Mixtures on the market with the same names have often been produced not only from different oil wells but also by different processes. It is clear, however, that a physico-chemical specification for an anti-malarial oil is urgently required. Provisionally we carry out three rough empirical tests: the oil should have a greater spreading pressure than that of castor oil; it should form a fairly complete stable film when sprayed on water in the customary amounts; and Anopheles larvæ below such a film at 24° C. should all be dead in two or three hours.

With some types of water, notably where much vegetation is present, 'dusting' is preferred to oiling. This consists in blowing over the water a cloud containing one or two parts per cent of Paris Green in a vehicle of dry dust. Anopheles larvæ feed at the water surface and are poisoned by the floating particles. Apart from some information about the size of particle ingested by the larvæ, knowledge of this subject is at the empirical stage.

The last method of control I intend to mention (there are many more) is known as 'shading'. This has been developed principally and with great success by Ramsay[7] in Assam and northern Bengal against *A. minimus*, a species closely allied to *funestus*, and which likewise breeds in grassy edged streams. It has been found that if suitable bushes are planted along these streams so that they are densely shaded, *A. minimus* disappears. But the cause of its disappearance has been a matter

for speculation. Does the female avoid shaded waters in laying her eggs; or is the shaded water unfavourable for the development of larvæ?

During the last three years R. C. Muirhead Thomson[8], supported by the Royal Society and the London School of Hygiene and Tropical Medicine, has been working on this problem in the tea gardens of Assam. Briefly, he has shown that although the female *A. minimus* lays her eggs during the night she prefers to lay them in the shade. At a light intensity one quarter of starlight she will still show a preference for deeper shade; below 0·000008 ft. candle, about one tenth of starlight, she becomes indifferent. Yet egg collections in the field show that she does not lay in the shaded streams. Thomson has proved that this is because she will not lay in moving water. Under laboratory conditions she refuses to lay in water flowing at a rate of 0·05 ft. per sec. Normally she finds both shade and still water among the grass at the margins of the streams. All this vegetation is eliminated by shading.

Shade also exerts an effect upon the larva. Contrary to general belief these stream-breeding larvæ have very weak powers of resistance to flowing water. *A. minimus* larvæ cannot remain anchored if the rate of flow exceeds 0·29 ft. per sec. They normally find the still water necessary to their security in the grassy margins. They are kept there, not by an avoidance of moving water but by a reaction to light and shade which is enhanced by flowing water.

In this reaction to light are several elements: (1) a photokinesis or increased activity in bright light. This may be inhibited by thigmotaxis if the larva is anchored to some object. (2) An undirected avoiding reaction on passing from shade to light. (3) A directed reaction or phototaxis towards an area of shade. Under experimental conditions the larva can be made a victim to these responses, and by shading the middle of a stream can be caused to leave the margin where it is safely anchored and swim to the middle, where it is swept away by the current.

This work illustrates well enough how right the malariologist may be in his methods and how completely in the dark as to their mode of action. He has no time and often receives no encouragement to probe deeply into such matters. Here lies a vast and profitable field awaiting the attention of research workers informed on modern biology and unhampered by the need of producing immediate practical results.

[1] Hackett, L. W., "Malaria in Europe" (Oxford, 1937).
[2] Christophers, S. R., *Trans. Roy. Soc. Trop. Med. Hyg.*, **33**, 277–304 (1939).
[3] Wigglesworth, V. B., NATURE, **136**, 338 (1935).
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APPLICATION OF PLANT GROWTH SUBSTANCES IN PRACTICE*

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In order to focus attention on certain aspects of the application of biological science to those industries concerned with the growing of plants, it is proposed to consider briefly one example, perhaps already familiar to some readers of NATURE.

The Fundamental Research

For very many years it was a commonplace observation that the stems of most plants usually grew towards light, yet the elucidation of the mechanism involved took place comparatively recently. The physiological investigations of tropisms, as such growth movements are called, were carried out in university laboratories at Copenhagen by Boysen Jensen and at Utrecht by F. A. F. C. Went and his associated workers; during the years 1910–27 they progressed steadily yet bore no obvious signs of having any practical application.

In 1927 Went[1] reported the isolation from, and reintroduction to, the tissues of seedling oats of one (or more) active hormone capable of controlling the rate of growth in length of the tissues of the young shoot. A technique was gradually perfected whereby minute traces of the active substance could be estimated in relative but quantitative terms, or 'oat-units.' Some six years later a team of biochemists led by Kogl[2] determined the chemical composition of auxin *a* and its related form *b*, as these hormones were named; they proved to have an elaborate structure (*a* C_{18} H_{32} O_5). Whilst searching for a ready source of these compounds Kogl tested urine; by good fortune he found a third substance with activity of a similar high order of magnitude, 25 million oat-units per milligram, but of much simpler constitution.

* Substance of the second paper contributed to the discussion held at a joint meeting of the Association of Applied Biologists and the Society for Experimental Biology held on March 28

This was quickly recognized as indolyl-3-acetic acid, a compound soon readily available for numerous investigators to apply to the tissues of many plants in various ways[3].

Some of the Plant Responses

Small quantities in lanolin, at 0·1 per cent, applied to the stems of quickly growing plants such as tomatoes, caused twisting and bending of the stems and petioles and drooping of the leaves. After 24–48 hours, rapid cell division had begun in the region of the cambium and inner phloem and elsewhere. After a week or 10 days the division of the cells resulted in root formation, and in moist conditions these roots emerged to the air through the outer tissues. This was a response of high potential practical value and at once attracted the attention of applied biologists familiar with the problems of vegetative propagation[4].

Another response observed was the retardation of the development of buds on the stems.

Chemical Expansion

Using other plant tissues, sweet-pea stems, as testing materials, Zimmerman, Wilcoxon and Hitchcock[5] added to the list of active substances α- and β-naphthylacetic acids, indolylbutyric acid and other substances and later (1936[6]), the esters of these and other related acids which, like the metallic salts, also proved active. As numerous additions were made it became increasingly difficult to correlate chemical configuration with physiological activity. Linser[7] in 1938, cited more than fifty active substances; among more recently added compounds may be mentioned naphthylacetamide and thionaphthylacetamide (Stoutmeyer[8]) and naphthylideneacetic acid (Tincker[9]). Stereo-isomerides may differ in their activity as shown by Zimmerman[10] with the cinnamic acids and by Tincker with the naphthylideneacetic acids. Although indolylacetic acid is closely related to tryptophan, which is a possible precursor in plant tissues when parallel deamination is carried out with tyrosine and phenylalanine and histidine, the activity of the acids so derived is of a low order.

Application in Propagation

The earlier attempts were made using lanolin pastes applied directly to the stem, or after glycerine had been rubbed into the tissues, or into longitudinal incisions made in the stems of woody cuttings. Laibach[11] was able to accelerate the rooting of cuttings of the apple stock Doucin XI, and of *Prunus mahaleb* and to increase the number rooted of *Parrotia persica*. Among early successes may be mentioned Cooper's[12] experiments with lemons and Zimmerman's[13] with American holly treated with dilute solutions. In Great Britain from early 1936 onwards, extensive tests of naphthylacetic, indolylbutyric and indolyl acetic acids have been made with a wide range of plants at Wisley, and at Kew by Templeman and Metcalfe[14], at East Malling by Pearse[15] and Garner, also at Reading by Stoughton and Plant[16] and elsewhere. In 1939 an index was prepared by Pearse[17] showing the practical results with these substances; a thousand entries were obtained. Among economic plants, fruit stocks, bush fruits, coffee, citrus and vines occur in this list. Thus after three or four years of applied work it may be justly claimed that the use of these substances was established.

Among plants well known to be difficult to propagate vegetatively there is a gradually decreasing number of unresponsive species. Thimann and Lisle[18] have reported success with *Tsuga canadensis*, *Picea pungens*, *P. abies* *Pinus insignis*, has responded at Wisley[19]. Grace in Canada tested the Norway spruce[20]. Afanasiev tested Betula, Acer and Populus[20]. Such results are directly applicable to forestry, as are those of Plank[21] with pine seedlings. To-day these results have added significance if our forests are to be maintained. Chrysanthemums are readily propagated, but the increased number of roots and larger root systems obtained by treatment is considered, by certain large firms, to be justified. The tests were made on a very large scale involving several hundred thousand plants. Thus was the 'mass production' stage reached.

The treatment given to cuttings varied in concentration with the nature of the tissues—herbaceous or woody. The response obtained varied according to the season of application—generally leafy cuttings responded better than hard wood. Over such details, perhaps of little interest to the experimental biologist, must time be spent by some biologist, for sound advisory services afford perhaps the best of all introductions to an industry in which skilled operators are rightly both critical and proud of their own achievements. Although greatly facilitating propagation, the use of these compounds does not replace technical skill.

Following the work of Bonner[22], Green[24], and Robbins[25], who found that vitamin B_1 (aneurin or thiamin chloride) was necessary for the continued growth of roots, *in vitro*, other investigators (Went, Bonner and Warner[26]) reported that traces of B_1 accelerated the rate of root growth. When added to the growth substances and applied to cuttings at Wisley[22] the results proved very uncertain (certainly aneurin did not alone induce root formation), and only in a very few cases did it cause more rapid growth of stems or roots. More encouraging results were seen at Leverkusen in 1938.

Aspects of Marketing

By the aid of various solvents, proved not toxic to the plants at the ultimate dilution employed, solutions became available. The results obtained quickly attracted the keen attention of enterprising chemical firms. In the United States indolylbutyric acid was marketed 'under licence', or some measure of supervision of the research institute that proved its value. Other firms, some perhaps less scrupulous, copied this venture. In Great Britain one firm quickly marketed a readily available but relatively ineffective compound. Its sales were on a small scale. Naphthylacetic acid was later marketed in solution but was not sold pure; to it was added a mixture of carbohydrates, contrary to some advice tendered at the time. Although effective as a rooting stimulant this solution was promptly reported to become 'cloudy' and to encourage bacterial and fungal decay in some cuttings. Another firm was therefore approached and indolylbutyric acid was consequently marketed; it also appeared under a trade name but the contents were declared. A further firm marketed the solutions under their chemical names giving full details of the contents.

Powders are now available[27] in which the active substance is diluted with talc, fuller's earth, or similar inert substance. Although speedier to apply—the wet cuttings are quickly dipped into the powder and sufficient adheres—they are not quite so effective as solutions. They may be purchased in different concentrations. Another form of preparation is in pellets, made to dissolve in readily measureable units of water, thereby solving the problems of dilution for amateurs. Other devices for obtaining correct dilution have been marketed, including small measuring tubes and dropper measures. Instructions are usually provided.

The advertisements of our reputable firms have, on the whole, adhered strictly to the facts; the same cannot be said of all firms in all countries where "miracle rooting solutions" are advertised.

The dissemination of knowledge of these substances and their proper use has been carried out by articles in popular papers, in the gardening Press, by broadcasting, by exhibits at shows, by advisory letters, lectures to trade guilds, and other means, including advertisements.

Application of Growth Substances to entire Growing Plants

Grace[28] reported that seedlings watered with indolylacetic or naphthylacetic acid at certain concentrations between 10^{-7} and 10^{-4} grew more vigorously than did controls or seedlings receiving heavier applications, which damaged the tissues. The plants tested were Nasturtium, Salvia and tomato. More stimulation occurred in sand than soil. Similarly Amlong and Naundorf[30] reported stimulation, but Templeman[31] found that indolylacetic, naphthylacetic and ascorbic acid gave no significant increase in dry weight when applied as a spray or by watering the soil with solutions.

In a series of experiments made at Wisley[9] with dilutions varying from 0 through 10^{-7} to 0^{-1} indolylacetic acid, naphthylacetic, tetrahydronaphthylideneacetic, glyoxaleneacetic and other compounds proved ineffective, for no stimulation was observed. The plants used were annuals. Templeman and Marmory[32] obtained generally similar negative results with lettuce, with mustard and tomato.

Grace[33] reported stimulation with indolylacetic acid and naphthylacetic acid at two parts per million seed weight, when dusts were applied to grain at the rate of ½ ounce per bushel. Later Grace found that the application of the growth substances to cereal seeds more than overcame the ill effects of grain treatment with formaldehyde.

In a field trial McRoster, Hopkins and Grace[34] again obtained increases in yield, 13 per cent grain and 20 per cent straw, but the results were variable. The growth substance was applied with a proprietary mercury fungicide. Croxall and Ogilvie[35] obtained with peas, in sterile soil, an increase in dry weight by treatment with various seed dressings to which growth substances were added. They also found that the check to growth caused by mercurial dressings was largely or entirely overcome by the addition of naphthylacetic, indolylbutyric and naphthylideneacetic acids. The crop yields were greatly increased—up to 80 per cent increases were found.

A somewhat similar experiment at Wisley gave negative results at early stages of growth. No stimulation occurred with other seeds, including lilies. In a recent private communication, Ogilvie states that with other plants, lettuce and beet, he has not obtained such stimulation as he observed with peas. Similarly Templeman and Marmory[32] found that with oats, wheat, barley and sugar beet, in sand and soil tests, in pot and plot experiments, seed dressings containing naphthylacetic or indolylacetic acid in talc did not stimulate growth or dry-matter production.

Only further work can elucidate these apparently contradictory results; as yet no recommendations can be safely made to practical growers, and thus in three years little advance has been made in this application.

VITAMIN B_1 APPLIED TO THE SOIL

From its structure thiamin chloride does not appear likely to be a stable substance when exposed to bacterial activity in soils. Yet in the popular American Press extravagant claims have been made of the stimulation to growing plants that results from its application to the soil. In July 1940, some three hundred and fifty firms were selling vitamin B_1 under various trade names. The considered report of the Bureau of Plant Industry shows that no reliance can be placed on the results. Hamner[25] in tests made with long- and short-day plants under controlled periods of light obtained no effect by its use at reasonable rates. It proved quite ineffective. In Great Britain the substance can no longer be purchased as a plant stimulant as it is required for addition to bread. In this matter commercial enterprise has outstripped applied science; perhaps stricter control should be exercised to prevent exploitation of the public, more especially when every endeavour is being made by an increasing number of people to grow more food. Firms of established repute are reluctant to market such preparations for such purposes.

OTHER USES

Gardner, Marth and Batjer[27] applied naphthylacetic acid and naphthylacetamide to fruit trees, and by delaying the formation of the abcission layers prevented the early June drop of apples. This work is now being followed up at East Malling. The formation of parthenocarpic fruits induced by spraying with solutions of growth substances awaits wide commercial application, as does the retardation or inhibition of bud development along the lines of Guthrie's[28] work, but fruit bud retardation in relation to sprays is being studied in Great Britain. The effects of these substances observed by Zimmerman[29], on various storage organs of plants, has not as yet been applied on a commercial scale.

GENERAL OBSERVATIONS

The study of only one example does not permit generalizations of much value to be made, but certain observations bearing on the general discussion are perhaps permissible.

(1) The 'long-range' work undertaken with no thought of commercial practice extended over many years in its physiological and biochemical aspects. It led to the isolation of auxin.

(2) A wide "chemical expansion" whereby many substances were proved active followed during the subsequent five years.

(3) The details such as concentration, time of uptake, or points of technique required some three or four seasons for establishment. Thus the actual application of laboratory discovery to an industry based on seasonal procedure takes several years. Possibly in a few cases this period of testing might be materially reduced, but where plants or crop varieties may react differently the period cannot be greatly reduced.

(4) The actual marketing and use of such substances raises questions of control, of proprietary substances, and advisory services.

The business houses accomplish a large part of the necessary publicity but cannot undertake all the necessary advisory duties. It is essential to make the information readily and quickly available.

(5) The immediate necessity is to remove all obstructions in the flow of knowledge at any point from *A* to *Z*, from pure research to industry. 'Bottle necks' may occur at various stages through lack of co-operation by men of science, and more frequently in the lack of dissemination of accurate information.

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MINERAL RESOURCES OF CONTINENTAL EUROPE*

By Dr. W. J. Arkell

The Balkans

The Balkans have for a long time been a region towards which German industrialists, prospectors and geologists have turned acquisitive attention as a source of mineral wealth. The political status of the countries there ranges from some completely subject to the Axis (Rumania, Hungary, and Bulgaria), through a country in process of being freed from Axis control (Albania), and one which has just declared against the Axis (Yugoslavia), to one actively allied for some time past with Great Britain (Greece). Political conditions are as usual so unstable that only a non-political order of treatment can remain valid for any length of time.

Hungary, now in possession of former Rumanian territory, is grouped with the Balkans for convenience.

Hungary

Oil. With a production of more than 103,000 tons in 1939 Hungary was nearly self-supporting in oil.

Manganese. By 1938 Hungary was producing her domestic requirements of high-grade manganese ore and exporting quantities to Germany.

Aluminium. Hungary has by far the biggest bauxite deposits in Europe, amounting to at least 40 per cent of the total and perhaps much more. Up to 1937 the production was 25 per cent, second to France (32 per cent). According to some published estimates, the Hungarian total reserve is nearly 500 million tons, which would be by far the largest of any country in the world.

Rumania

Oil. With a production of 8¾ million tons of crude oil in 1936, and 6¼ million tons in 1939, after three years of neglect of new drilling, Rumania constitutes the greatest mineral prize in all Europe for the blockaded Axis powers.

Copper was worked extensively by the Germans in the War of 1914–18.

Manganese is produced in many regions. The total reserves are estimated at about 9 million tons of ore with 14–40 per cent manganese.

Chromium. The Germans are reported to have obtained about 40,000 tons of chromium ore during the War of 1914–18 and the total reserves are estimated at 2 million tons.

Molybdenum. Rumania is the second largest producer of molybdenum ores in Europe, coming after Norway, with about 14 per cent of the recent annual production, equivalent to 90 tons of metallic molybdenum. The year 1938 showed a great jump in production which indicated that considerable expansion is possible.

Aluminium. It is estimated that Rumania, even with its new frontiers at the end of 1940, contains 20 million tons of bauxite reserves, as yet scarcely developed.

Pyrites deposits are considerable, amounting to about 10½ million tons.

Mica occurs in fair quantities. The production in 1936 was 66 tons, or second after Sweden, but it has since declined.

Bulgaria

Copper. Bulgaria is estimated to have a reserve of at least half a million tons of probable ore with 4½ per cent copper and more with 2–3 per cent.

Manganese. Germany acquired 30,000 tons a year of good manganese ore from Bulgaria during the War of 1914–18.

Chromium. In recent years there has been a rapidly expanding production of chromite and there are known to be new deposits not yet developed.

Yugoslavia

Yugoslavia is one of the richest of European countries in metals.

Copper. In recent years Yugoslavia has led European countries in the production of copper, with 28·5 per cent of the total in 1937, and the production increased in 1938. The ore body at Bor is the second largest in Europe after that at Outokumpu in Finland.

Zinc and Lead. In 1937 Yugoslavia produced 11 per cent of the European zinc and 26·5 per cent of the lead—a lead production second only to Germany's. The Trepca ore body is the most important source of lead in Europe, with a reserve of nearly 4 million tons estimated to contain 9·5 per cent lead, 5·2 per cent zinc, and some silver.

*Continued from p. 407.

The Misitsa lead mines produce ore with 11 per cent lead and 5 per cent zinc.

Manganese. Germany acquired 48,000 tons a year of high-grade manganese ore from Bosnia in the War of 1914–18. Since then another extensive deposit has been developed.

Chromium. Production has increased steadily from numerous deposits and Yugoslavia already leads in European production. It is believed that prospecting will reveal still further deposits. The 1937 production of nearly 59,000 tons of ore, containing 28,000 tons of chromic oxide, was equivalent to 45 per cent of Germany's imports in the same year.

Aluminium. Yugoslavia contributes 16 per cent of the total European production of bauxite, and her reserves amount to 80 million tons, or 22 per cent of the proved European total.

Magnesium. Large deposits of magnesite have only recently begun to be worked and many more are still untouched. The magnesite is of the highest quality and could sustain large-scale exploitation for at least half a century.

Mercury. Large deposits of cinnabar occur in several parts of Bosnia and Serbia, and there are others in Dalmatia and northern Macedonia. At one time Serbia alone produced an average of nearly 140 tons of mercury a year (about one tenth that of the Spanish output in 1937).

Antimony. There are important deposits in Serbia and smaller ones elsewhere. With a production in 1937 of 4·35 per cent of the total antimony production of Europe, Yugoslavia easily heads the list of producers. But in 1938 the production was nearly doubled, amounting then to 3,370 tons of metal. This amount is nearly five times the production of the whole British Empire and three times that of the United States.

Pyrites occurs in large quantities at Maidanpek and Bor in Serbia, and also in Bosnia (see under copper).

Mica. In Macedonia there is a workable reserve of at least 300,000 tons of sheet mica.

Albania

Oil. With a production of more than 207,000 tons in 1939, Albania has been a precious source of crude oil to Italy and its loss would be serious.

Chromium. Extensive deposits of good quality chrome ore were recently discovered in the neighbourhood of Lake Ochrida.

Pyrites. Large lenses of high-grade pyrites as yet undeveloped, but easily accessible, may contain a reserve of up to 20 million tons, or 2·6 per cent of the European total.

Greece

Chromium. Greece, with a production of 42 per cent of the European total, is second only to Yugoslavia (56 per cent). The production has been rising rapidly and could doubtless be stimulated considerably. If Germany acquired control of the mines as well as those in Yugoslavia her needs in chromium would be satisfied.

Aluminium. Production of bauxite increased more than tenfold between 1935 and 1937, to 6·5 per cent of the European production. The reserve is about 5 million tons, or only 1·3 per cent of the European total.

Magnesium. Vast quantities of exceptionally pure magnesite occur. In 1937 Greece accounted for 21·3 per cent of the European production, second only to Austria (60 per cent).

Pyrites. There are reserves of at least 5 million tons. Greece is sixth among the producing countries of Europe.

Spain

Iron. Although only accounting for 3·7 per cent of the European output in 1938, Spain contains more than 10 per cent of the European reserves of metallic iron. Among them are some of the largest deposits of Bessemer ore in the world, conveniently placed for shipment.

Copper. The huge pyrites and chalcopyrite deposits at the Rio Tinto mines contain 60 per cent of Europe's reserves of metallic copper. The production in 1937 was only 18·5 per cent of the total European production.

Lead. Spain produces 11·4 per cent of the European total of lead, but only 4·6 per cent of the zinc.

Manganese. There are high-grade ores in many provinces, and the production in the past has averaged more than 100,000 tons a year.

Vanadium occurs in small percentages in lead and zinc veins and also in phosphates. Of the latter there is a probable reserve of 200 million tons with 0·25 per cent vanadium—a total of half a million tons of metallic vanadium.

Mercury. The cinnabar deposits of Almaden are the largest and richest in the world. In spite of primitive methods of working, Spain headed the world production until 1937.

Phosphates. The phosphate deposits of Spain are believed to amount to 23 per cent of the European total (in terms of P_2O_5).

Pyrites. Nearly half the world's total reserve of pyrites occurs in Spain, and 63 per cent of the European reserves. Spain leads European pro-

duction with about 37 per cent, after which comes Norway with 17 per cent.

Potash. Spain possesses 8·6 per cent of the European potash salts, or nearly half those known outside Germany (the only others being in Alsace and to a much smaller extent in Poland). So far her output does not amount to 5 per cent of the total European production.

Portugal

Copper. About 8 per cent of Europe's copper reserve is in Portugal. In 1937 the production was 5,518 tons of metallic copper, or 3·8 per cent of Europe's total.

Tin. Portugal is at present the only country producing anything but negligible quantities of tin. The amount, however, is not very great (maximum 1,435 tons in 1939).

Tungsten. Portugal produces 94 per cent of the tungsten output of Europe. In 1938 the amount was equivalent to 1,660 tons of WO_3. Germany, in the same year, imported ores to the amount of about 9,000 tons of WO_3; but in 1936, when she was not building up stocks for war purposes so actively, her imports of ore amounted to only about 5,800 tons of WO_3. The Portuguese supply is therefore equal to meeting at least 25 per cent of the normal German demand for tungsten.

Titanium. In 1937, 1,433 tons of ilmenite were produced.

Uranium. In 1936 Portugal had the second largest uranium output in the world, after Bohemia, representing 40 per cent of the European production.

Pyrites. Portugal is responsible for about 10 per cent of the European pyrites production; but her reserves are not one twentieth the size of the Spanish.

Sweden

Iron. The Swedish iron ores are the richest in Europe. The production is 29 per cent of the European total, in terms of metallic iron, and the reserve is 13 per cent of the total reserve.

Zinc and Lead occur in important quantities. Sweden accounts for 8 per cent of Europe's zinc production.

Tungsten. Sweden is the only other country besides Portugal that produces appreciable quantities of tungsten. In 1938 she produced tungsten ore equivalent to 108 tons of WO_3 and also exported 1,510 tons of ferro-tungsten.

Molybdenum. About 4 per cent of the European output of molybdenum is produced in Sweden; but the amount could be increased.

Vanadium. The Swedish iron ores, like the German, contain small quantities of vanadium, which is recovered during the smelting, both in Sweden and in Germany. The percentage is low; but the aggregate recovery of vanadium is highly important.

Titanium. Most of the Swedish iron ores are more or less titaniferous, like the Norwegian. The Taberg ore body especially contains 4–10 per cent titanium and could yield large quantities of titanium if necessary.

Arsenic. One of the world's largest deposits of arsenic occurs at Boliden mine, worked for gold, silver, copper and sulphur. The arsenic produced as a by-product exceeds the whole world's consumption.

Mica. The small Swedish mica industry heads the European production with 129 tons in 1938 (34·5 per cent).

Finland

Copper. Finland has three important copper districts, which together contain 7·5 per cent of the European reserves of metallic copper and account for 8·6 per cent of the production. Outokumpu is the largest known copper ore body in Europe.

Pyrites. The copper ore body of Outokumpu contains a pyrites reserve of probably 20 million tons, which is about the same as the estimated pyrites reserves of Portugal and Albania respectively.

Asbestos. Finland heads the European production of asbestos, with 43·5 per cent of the total. The bulk of the exports usually go to Germany and Sweden, and since the percentage of the European production within Germany and the conquered territories is only 18, this trade is of importance to Germany.

Possibilities of the U.S.S.R.

To what extent can the U.S.S.R. help the continent of Europe to be self-supporting in mineral resources? Many important metals, especially copper, lead, tin, nickel, tungsten, molybdenum and antimony, she imports for her own needs and so competes with Europe. There are, however, a few important commodities of which she has such an abundance that there is a substantial surplus even after her own huge consumption has been met.

Oil. The surplus of production over domestic consumption was 6·5 million tons in 1938 and 7·5

million tons in 1939, and this could be increased by restricting internal consumption. Petrol rationing was introduced in Russia as from January 1, 1941. Russians claim in recent years to have discovered many vast new oilfields containing reserves of more than 6,000 million tons of crude oil, or three times as much as the present proved reserves of the United States and nearly 60 per cent of the world's total reserves. It is still uncertain how far these claims are justified.

Manganese. More than 70 per cent of the world's reserves of manganese ore are in the U.S.S.R., and in 1937 Russian production was 46 per cent of the total world production. It has been stated that under the Russo-German trade agreement of September 1939 the U.S.S.R. guaranteed Germany half a million tons of manganese ore a year, or more than required for the total steel output of Germany, Austria, Czechoslovakia and Poland in the year 1937.

Chromium. In the year 1936 (the latest for which figures are available) the U.S.S.R. had a larger production of chrome ore than any other country in the world, and she exported more than 3,000 tons of chromates.

Magnesium. In the year 1937 the U.S.S.R. produced about 40 per cent of the world's total production of magnesite, far more than any other country. This is of no advantage to Europe, however, since Europe itself has ample deposits and accounted in the same year for 36 per cent of the world's production.

Zirconium. The Kola Peninsula and the Urals contain considerable deposits of zirconium, which formerly were worked successfully and could be reopened in case of need.

Platinum is produced extensively and is a metal entirely lacking in Europe.

Fertilizers. Russians have claimed recently to have proved vast reserves of phosphates and potash in the U.S.S.R., by far exceeding those in all the rest of the world. Central Europe already has a glut of potash salts, but urgently requires phosphates. Russia exported apatite, phosphate rock and superphosphate to the extent of more than half a million tons annually in 1936 and 1937, while in the first half of 1938 the figure rose to a rate equivalent to more than a million tons a year.

Asbestos. In 1936 the U.S.S.R. produced 24·5 per cent of the world output of asbestos, and exported more than 25,000 tons. The exports increased to more than 27,000 tons in 1937.

Graphite. Although in 1935 the U.S.S.R. produced about 38 per cent of the world output of graphite, she exported none in 1937 or 1938.

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NEWS AND VIEWS

Yugoslavia

GERMANY'S attempt to fasten a strangle-hold on Yugoslavia by 'diplomatic means' may prove to have been an even greater blunder than the miscalculation of Mussolini's threat to Greece. The Axis powers, like Germany in the War of 1914–18, have shown themselves singularly inept in estimating the force of the spirit of resistance in a free people prepared to endure suffering even to martyrdom in defence of a way of life and a tradition which embody their highest ideals. No doubt the German leaders have been confirmed by their experiences of recent years in a cynical realism which backs mechanized forces against an idealism with little to rely upon beyond the strength of its right arm and the justice of its cause. Yugoslavia, however, stands in a category different from those nations until lately free, which have succumbed to the traitor within their gates. By the bloodless revolution of March 26–27, Yugoslavia, to quote Mr. Churchill, "found her soul". Her three peoples stand united in their resistance to aggression. Nor must it be forgotten that each one of them has a long and honourable tradition in the cause of freedom.

When the German Führer sought to bring Yugoslavia into subjection as Rumania and Bulgaria had been brought into subjection, had he forgotten how the reorganized Serbian army in the War of 1914–18, after three years of exile and eclipse, showed themselves worthy sons of the heroes of the field of Kossovo, how they were the first of the Allied troops to break through the ring of the Central Powers, and how in a drive, which in the difficult conditions of the terrain was little if at all less spectacular than some of the recent advances of British troops in Africa, expelled the enemy from their country within a few weeks? Now Yugoslavia has been forced to take up arms, her army, composed of men who are among the bravest and strongest fighters in the world's armed forces, aided by the difficulties of a country which offers little facility for the technique of mechanized warfare, may well prove, as it did in the last War, the pivot upon which will turn the struggle on behalf of freedom. As in the War of 1914–18 the health of the armed forces will need special attention. During 1916–17, malaria claimed a deadly toll. In fact, medical grounds might well prove ultimately as important as strategic (see page 436 of this issue).

The independence of Serbia from Turkey was established by the Treaty of Berlin in 1878. After the revolution in Austria-Hungary, Slovenia, Croatia, Dalmatia and Bosnia declared their independence, and their union with Serbia, together with that of Montenegro, which had been voted on November 13, 1918, was proclaimed on December 1, 1918, when the official name of the State was announced as being the Triune Kingdom of the Serbs, Croats and Slovenes. Further modifications of boundaries followed, and on October 3, 1929, the name of the State was changed to the Kingdom of Yugoslavia. The estimated population at the beginning of 1936 was nearly fifteen millions. All religions recognized by law enjoy the same rights, and comprise the following: Serbian Orthodox, 48·7 per cent; Roman Catholic, 37·45 per cent; Greek Catholic, 0·32 per cent; Protestant, 1·66 per cent; Moslem, 11·2 per cent; Jews, 0·49 per cent; others, 0·18 per cent. Primary education is free and compulsory. Secondary, technical and agricultural educational facilities are good. There are three universities, namely, the University of Belgrade with about five thousand students, University of Zagreb with about five thousand students, and the University of Lyublyana, founded in 1920.

Agricultural Policy in Great Britain

ON April 3, the House of Commons went into Committee of Supply on a supplementary vote for the Ministry of Agriculture. The Minister (Mr. R. S. Hudson), in his reply to Earl Winterton, pointed out that between 1914 and 1918, before Mr. Lloyd George started his food production campaign, about 32 per cent of the cultivable land of Great Britain was under crops. By the end of 1918 that was raised to 38 per cent. At the beginning of this War, the percentage was only 28, but in the same period it has been increased to 40 per cent. Thus, in the War of 1914–18, 2,300,000 acres were ploughed up, and it is to be expected that by this spring 3,750,000 will be ploughed up. Against this, it must be realized that the population of the United Kingdom has risen since 1917 from 41,000,000 to 47,750,000, while the land available to provide the food has decreased by 2,500,000 acres. Thus, the farming community has made a very remarkable contribution to the British war effort. The farming survey is to be revised and will be of great value for the food production campaign and even more valuable to the post-war agricultural policy.

The Minister of Agriculture is persuaded that the quickest and biggest increase in production can be obtained by increasing the productivity of the existing arable land, improving the existing grassland, and above all by raising the standard of farming. In the last seven months, the various committees have done very nearly as much towards draining land as it took the Italian Government thirteen

years to do in reclaiming the Pontine marshes. Many parks, too, have been ploughed up. Golf courses are not so valuable, but where they can make a substantial contribution they will be asked to do so, while those unsuitable for ploughing will be used for grazing sheep.

In regard to research, the Agricultural Research Council is to be granted an increased sum for use at its unfettered discretion for promoting basic or fundamental research (see also p. 434 of this issue of NATURE). Thus it is hoped to use for the advantage of agricultural research the best brains of the scientific world. The Minister proposes to appoint for England and Wales a body which will be directly responsible to him and which will be concerned to devise methods for ensuring that promising results of research are applied as rapidly as possible to the problems of agriculture and incorporated in the everyday practice of the farmer. A similar body is to be appointed for Scotland. The question of the reform of agricultural education is also to be considered.

Science and Democracy

THE American Association for the Advancement of Science recently forwarded to the British Association a resolution adopted by its Council, inviting the collaboration of British men of science with their American colleagues in framing a charter of democracy on scientific principles. The resolution was passed to express whole-hearted support of the rights of free peoples of the world and the desire of scientific men to share in the responsibility of maintaining them at this time of international stress. It was intended as a significant joining of 'hands across the sea' in a common cause and with the hope that the grasp might lead to effective action.

When this expression of unity of feeling and purpose with Great Britain in the present War was communicated to the Council of the British Association, the resolution was referred to the Committee of the Division for the Social and International Relations of Science. It need scarcely be said that the friendly approach from the United States was highly appreciated, and the co-operation suggested was gladly undertaken. The wording of the American resolution invited co-operation "in attempting to formulate, upon scientific principles, an international charter of democracy". It became clear, however, from inquiries that this phrase represented an attitude and a hope, and was not intended to be a precise term of reference for any committee which might be appointed by either of the two Associations to consider the subject. The Committee of the British Association Division therefore decided first to formulate a statement of the democratic fellowship of science, believing that such a charter would include the basic elements of scientific principles of democracy. This charter has been drafted and communicated to the American Association as well as to the Council of the British Association, as a contribution to the co-operative effort of English-speaking scientific communities to promote the advancement of knowledge and action in an international spirit. Whether a charter of the scientific commonwealth can be made the foundation of a world fellowship has yet to be considered.

University of Liverpool: Air Raid Damage

IN a recent raid on Liverpool some of the University buildings suffered damage. One of the engineering laboratories received a direct hit and was practically wrecked. Part of the Medical School was also severely damaged, but the effect here was less direct and the structure is not seriously impaired. Other buildings of the University suffered from blast, many windows, roof-lights, and doors being destroyed. There is, however, no reason to fear that the work of the University will be restricted; the remaining engineering laboratories are adequate to carry on the work of the Faculty with little reduction of efficiency, and repairs are proceeding rapidly on the other laboratories. The amount of the damage is estimated to be about £100,000, so far as it can be ascertained at present. Fortunately, there was only one casualty and that of a minor kind.

Engineers' Achievements under Aerial Bombardment

THE twenty-first annual general meeting of the British Electrical Development Association was held in London on March 21 under the presidency of Lord Lytton. The meeting was preceded by a luncheon at which the Minister of Transport was the guest of honour. In reply to Colonel Moore-Brabazon, Lord Lytton pointed out that, in the last twelve months, the electrical industry has undergone the severest test in its existence. In spite of air attacks, electricity supply has suffered no prolonged interruption, but few of the general public have any idea what this has meant. Too many are apt to take it for granted, like all the other machinery of civilized life to which they are accustomed. In the first place, this 'maintained supply' was due to improvements in the distributing system which were carried out in the years before the War. It would not have been possible at the time of the War of 1914–18. The national pool of the whole industry, the interconnexion of the mains of different supply authorities and the amalgamation of different competing authorities—measures taken during peace-time—made 'maintained supply' possible. But even so, the results achieved during the past year have been due to the individual bravery of the men who operated the supply.

Lord Lytton expressed the hope that the day is not too far distant when we shall again think more in terms of 'development', because, despite the alarums and excursions of war-time days, the electrical industry has an eye—and a very constructive eye—to the future. In so far as anyone can visualize the problems of reconstruction with which we shall be concerned when the War is ended and the means available in solving them, the Association and various sections of the industry have given considerable thought to the many ways in which electricity can

make its contribution to the planning and building of a Britain that will at least be a more comfortable place in which to live.

Economics and Finance

In an address on "Finance and the War" given to members of the Parliamentary Labour Party at the House of Commons on November 9, which has now been published by the Economic Reform Club and Institute, Prof. F. Soddy stresses the importance of distinguishing between genuine and fictitious credit if we wish to put an end to recurring economic booms and slumps and periodic world wars primarily of economic or monetary origin. We live in a world of potential abundance beyond our unscientific ancestors' powers of foreseeing, but that abundance cannot be realized until we clearly distinguish between the creation and the acquisition of wealth. All genuine money reformers are unanimous in demanding that money should not be put into circulation as a debt arbitrarily terminable, and most, if not all, that it should be paid into circulation by the nation for full value received by the nation.

In Prof. Soddy's view, the issue of new money under existing economic conditions is merely one form of forced levy in kind, for new money is a new legal claim by the issuer to anything of equivalent value on the market, with nothing to show that it is new or that the possessor in acquiring it has not given up the equivalent value and so has the legal right to claim it back on demand. He urges that the public should be instructed by its representatives that whether Parliament levies upon it, for the purposes of national expenditure, by recovering from it some of the existing money, by taxation, or by issuing new money, the proportion between the two forms of levy in money and in kind is dictated solely by statistical considerations to maintain a constant price-level and the money in proportion to what there is to buy, so as to secure uniform and general prosperity.

Electrical Music

A paper on "Electrical Music" which was read on February 1 to the Midland Section of the Institution of Junior Engineers by Dr. W. Wilson and is published in the March issue of the *Journal* of the Institution, summarizes in a very thorough manner the chief existing methods whereby musical sounds can be produced electrically. The most important developments have taken place in connexion with apparatus which actually create musical sounds in the first instance. The first actual mention of music as produced by an electric source was in connexion with Duddell's 'singing' arc, at the end of last century. The resistance of an electric arc decreases as the current rises. The result is that instability is produced, in the absence of a ballast resistance; thus the arc is continually going out and rekindling. If an inductance instead of a resistance is used and the whole is shunted by a capacity, a tuned circuit is formed in which the current will oscillate at a definite frequency. In so doing the current between the electrodes will actually be reversed twice per cycle, the arc going out at each reversal. No serious musical instrument has developed from the singing arc, although it achieved fame as a wireless transmitter when slightly modified by Poulsen. Within the past decade the howling of a valve in a wireless set has been a common example of electrically produced sound and it forms the basis of two musical instruments. Theremin has reproduced the conditions of the oscillating wireless set in his 'etherphone'.

The second application of the oscillating valve is for the construction of a complete electronic organ, a good example of which is that designed by Coupleux and Givelet, and installed in a number of French churches. In this there are 120 valves, which are caused to oscillate singly, and to generate a full range of notes which are very rich in harmonics. A very successful electric organ was invented by Hammond in 1934. In this there are 91 small alternators all driven from a common shaft which is itself driven by a synchronous driving motor. The sound which accompanies a talking picture can be derived from a wave track printed upon the celluloid film, through which a beam of light is projected into a photo-electric cell. Organs have been designed on this principle. In conclusion, Dr. Wilson points out the many advantages of the electrical method of producing music, especially when the electronic organ is employed. The power consumption is very low, it being usually possible to obtain all the energy required by plugging all the supply leads into any ordinary lampholder. The first cost is low, being between 30 and 40 per cent of the ordinary pipe organ, the maintenance costs are low, and it can always be trusted to maintain its exact tuning. Its progress up to the present has been remarkable, and there is every reason to foretell an equally rapid expansion of its use in the near future.

Trends in Air Conditioning

In an article in the *Electrician* of January 31, some significant trends in air-conditioning plants are discussed. The proved reliability of compact high-speed condensing units has made practical completely self-contained factory-assembled and tested 'packaged' air-conditioning units of ever-increasing size. Last year they reached 25 tons, and there is every indication that they will be increasingly popular. This trend began seven or eight years ago with small, compact, self-contained room coolers of about half a ton capacity, which were offered almost as soon as compact condensing units were developed. Later came the so-called store-type coolers, package units containing a condensing unit, evaporator, fan, and controls, completely piped, wired, charged and tested at the factory. The success of these units and the development of suitable compact, high-speed, condensing units has led to the more recent factory-assembled-and-tested central plant units of 7½–25 tons capacity. Those incorporate the features of a carefully engineered and installed central plant air-conditioning system, but are self-contained in a sturdy

steel frame. All piping work, oven vacuum dehydrating, charging and testing of the system are under strict factory conditions. The units are usually placed in a stock room at the rear of a shop, in the basement, or on a balcony, and are connected to the occupied space by means of a suitable duct system.

Radio Traffic Control in America

A NOVEL plan to bring traffic signals into cars in the form of distinctive tones corresponding to the 'stop' and 'go' lights, may in time make a car-radio a legal requirement on every car in the United States. In its present form, this traffic-control system uses the existing car radio tuned to 550 kc., thus making the system immediately available for the six million cars now equipped with auto-radios, though eventually a special small set would be employed with fixed tuning to the highway safety-signal frequency. By the use of this signal, the driver, instead of letting his attention wander from the roadway in his search for traffic signals in unfamiliar territory, would hear a pleasant low tone as long as the lights were green. When red comes on, in all cars in that section of the roadway an interrupted high note would be heard similar to that caused by a crossing signal.

Recorded messages can be used for continuous repetition of a message. The small highway transmitting unit, which may be mounted on a telephone pole or a traffic light stanchion, makes use of a magnetic tape sound-recording device. A distinctive sign placed on the street in advance of a given radio zone attracts the attention of motorists to the radio system which they are approaching and gives them the frequency to which to tune their set. By means of this device, traffic can be diverted to a secondary thoroughfare from crowded highways, preventing jams before cars have a chance to pile up, and drivers can be warned of speed limits or of emergency in case of fire or accident.

Data of Seismology

FROM the Government of India Meteorological Department comes the valuable *Seismological Bulletin* for October–December 1939. Interpretations of readings of the seismograms from Agra, Bombay, Calcutta, Colombo, Dehra Dun, Hyderabad, and Kodaikanal are given. Furthermore, J. H. Sil at Poona has collected 58 non-instrumental reports of shocks, five being in October, eight in December, and the remainder in November. Three of the reports noted earthquakes reaching intensity 9 on the Rossi-Forel scale. By far the strongest shock was on November 21, 1939, at about 11 h. 1 m. G.M.T. At Gilgit stones fell from the mountains, and dust spread all over the valley. At Drosh intensity 9 was reached, whilst at Srinagar the walls of the observatory and other buildings cracked.

The *Seismological Bulletin* of the Riverview College Observatory (New South Wales) for July, August and September 1940, has also been received. The Observatory is equipped with three Wiechert and two Mainka seismographs, the interpretation of the seismograms from which are given. The shock of July 31, 1940, was felt at Cape Nelson, Papua. The earthquake of September 12, 1940, was felt at Rabaul, New Britain, also in the Kokopo district, and at Wide Bay, Pondo, Namatanai and Buka. To this earthquake there were several strong after-shocks. The shock of September 21, 1940, was felt at Queanbeyan, New South Wales, but did no damage. Some deep-focus shocks were recorded, and some slight shocks lacked interpretation, since the area is to some extent troubled with microseisms.

Earthquakes near America

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has made a preliminary determination of the epicentres of the earthquakes of February 9 and February 11. The former had its initial time 9h. 44·1m. G.M.T., and on a basis of reports from 22 seismographic stations the epicentre appeared to be at latitude 40·7° N., longitude 125·4° W. This is in the Pacific Ocean just off the coast of California, in a well-known seismic region. The latter had its origin time 14h. 35·4m. G.M.T., and on a basis of reports from 18 seismographic stations the epicentre was calculated to be latitude 14·5° N., longitude 94·0° W. This is in the Pacific Ocean almost due west of Guatemala in Central America, also in a well-established seismic zone.

University of London: Certificate in Natural History

THE University of London has now published amended regulations (applicable for the duration of the present emergency) for its certificate of proficiency in natural history. The new scheme takes advantage of the fact that large numbers of urban teachers are now located in the country or at the seaside, and so presented with an opportunity of natural history study in the field which, under normal peace-time conditions, would have been impossible. The requirements embrace a directed course of private reading at home, attendance at a practical laboratory course of two weeks duration in the summer, an approved plan of field-work suited to the student's locality to be written up in the form of a substantial essay, and examination. Copies of the regulations and syllabus can be obtained from the University Extension Registrar, University of London, at Royal Holloway College, Englefield Green, Surrey. Several local education authorities are prepared to consider sympathetically applications for financial grants-in-aid from teachers in their areas who wish to study for the certificate.

Occurrence of Larger Fungi in the Tropics

A BRIEF note by E. J. H. Corner (*Trans. Brit. Mycol. Soc.*, **24**, 3 and 4; Dec. 1940) again directs attention to the interesting question of the occurrence of the larger fungi in the tropics. His experience in Malaya is in emphatic contrast to that of G. B. Masefield (*ibid.*, **24**, 64–67; 1940), who had suggested that large fleshy fungi are scarce in number and variety

in the tropics generally, and that representatives of some of the better known genera are scanty or absent. Corner's evidence is to the effect that larger fungi are abundant numerically as well as specifically and generically, but that "their fructifications are seasonal, developing quickly and rotting quickly, during the first rains which follow dry weather, and that if one is not able to visit the forest daily during the right fortnight, no trace of these fungi will be found. As for variety, I have found in Singapore some sixty species of *Boletus*, twenty-six species of *Russula*, twenty species of *Hygrophorus*, etc., etc." The evidence, in brief, gives a clear indication that tropical conditions are by no means unsuitable for the higher Basidiomycetes, but that the collector must be on the spot at precisely the right time.

Health of Zanzibar

In his latest report, Dr. S. W. T. Lee, senior medical officer in charge, Zanzibar, shows that the health services for women and children are improving. The women's clinic is attended by 150–200 patients daily, and in four dispensaries in the country the same work is carried on. Routine medical and dental treatment is given to school children, who all suffer, however, from nutritional defects. School feeding in certain places over a period of three months resulted in improved weight, height and health, but the Government is unable to finance the adequate treatment of all school children. The work of ante-natal clinics has steadily increased, and out of nearly 1,300 cases there was only one death which was due to puerperal sepsis.

Dr. George Oliver, 1841–1915

Dr. George Oliver, a well-known consultant physician and an authority on the examination of the blood and circulation, was born at Middleton-in-Teesdale, Durham, on April 13, 1841, the son of a surgeon. He received his medical education at University College, London, where he came under the influence of Dr. William Sharpey, the professor of physiology, and University College Hospital. He qualified M.B. London in 1865, and in 1873 obtained a gold medal at the M.D. London examination. Eventually he settled in Harrogate and soon acquired an extensive practice. In 1887 he was elected a fellow of the Royal College of Physicians of London, before which he delivered the Croonian Lecture in 1896, and in 1904 founded the Oliver-Sharpey lectureship in honour of his old master, the object of which was "to promote physiological research by observation and experiment, and to encourage the application of physiological knowledge to the prevention and cure of disease and the prolongation of life". Oliver's aim throughout his career was to make medicine a more exact science than it had been hitherto, especially as regards the blood and circulation; and with that end in view he invented several instruments such as the hæmoglobinometer, hæmodynamometer and arteriometer. He also devoted much attention to the study of the glands of internal secretion, especially the suprarenals, in conjunction with Prof. Schäfer. He died at Farnham, in Surrey, where he had been living in retirement for some years, on December 27, 1915.

Institution of Chemical Engineers: Medal Awards

The following awards were presented at the nineteenth annual corporate meeting of the Institution of Chemical Engineers held on April 4: *Osborne Reynolds Medal:* Mr. M. B. Donald, lecturer in (and at present in charge of) chemical engineering at University College, London, and joint honorary secretary of the Institution of Chemical Engineers, for meritorious services to the Institution during the year 1940; *Moulton Medal:* Mr. J. C. Farrant, of International Combustion Ltd., for his paper, "A Review of Certain Unit Processes in the Reduction of Materials"; *Junior Moulton Medal and Award:* Mr. S. A. Gregory, of Mousseo Ltd., for his paper, "Plant Design in Microbiological Processes"; *William Macnab Medal:* Mr. J. V. S. Glass, of the Castner-Kellner Alkali Co. Ltd., for the best set of answers submitted in the 1940 associate-membership examination of the Institution.

Announcements

We regret to announce the following deaths:

Prof. Herbert Freundlich, For. Mem. R.S., professor of colloidal chemistry in the University of Minnesota since 1938, on March 29, aged sixty-one.

Commandant J. G. Hackin, of the Free French Forces, formerly professor of archæology and Indian art in the Ecole du Louvre, Paris, by enemy action, aged fifty-four.

Prof. A. Lapworth, F.R.S., emeritus professor of chemistry in the University of Manchester, on April 5, aged sixty-eight.

Prof. J. S. Macdonald, F.R.S., emeritus professor of physiology in the University of Liverpool, on March 29, aged seventy-three.

The forty-seventh James Forrest Lecture of the Institution of Civil Engineers will be delivered by Prof. E. N. da C. Andrade, Quain professor of physics in the University of London, on April 29. Prof. Andrade will discuss "The Mechanical Behaviour of Solids".

Following a long and severe illness, Lieut.-Colonel W. A. Vignoles has been obliged to relinquish his appointment as senior managing director of Messrs. Evershed and Vignoles, Ltd. Mr. J. C. Needham succeeds him in that capacity, and Mr. M. Vines and Mr. D. D. Walker have been appointed additional managing directors. Colonel Vignoles worked as an apprentice with the predecessors of the Company, W. T. Goolden and Co., joining that firm nearly fifty years ago in the autumn of 1891.

Dr. Herald R. Cox, principal bacteriologist of the United States Public Health Service, has been unanimously nominated by the Theobald Smith Award Committee to receive the 1940 Theobald Smith award, consisting of a bronze medal and a sum of £200, for his outstanding research on Rickettsia diseases.

LETTERS TO THE EDITORS

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IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

Origin and Spacing of Slip Bands

SLIP bands on plastically deformed crystals are very much more equidistant than would correspond to statistical disorder; except in the first stage of deformation, their spacing fluctuates around a mean value which is usually between 0·5 μ and 10 μ. This remarkable phenomenon seems to have a simple explanation. Consider a crystal lattice subjected to a shear stress σ which produces the elastic strain $s = \tan \alpha = \sigma/G$ (G is modulus of shear). Suppose that slip takes place in the slip plane p–p (see accompanying diagram) over an area the linear dimensions of which are great compared with the atomic distance, but small compared with the size of the crystal. The slipped area is surrounded by a dislocation zone D,D, and the stress in its immediate neighbourhood has fallen to a small amount which we assume to be zero. The question is, how far the zone of greatly diminished stress stretches on the two sides of the slip plane.

For a rough estimate, we replace the curved lattice lines AB by two straight lines, one being tangential to AB in points A remote from the disturbed zone, and the other tangential in the point B where the stress vanishes. In other words, we assume that the stress vanishes on each side of the area of slip in a zone of width $d = BC$, and then suddenly assumes its initial value σ. The width d of the stressless strip is easily determined. On one hand, the horizontal shift of the atoms at the slip plane is $BC \tan \alpha = d.s$; on the other hand, it must be at least half of an atomic distance a in the direction of the slip. Thus the smallest value of d is given by

$$s.d = 1/2\ a,$$

or

$$\sigma.d = 1/2\ Ga. \qquad (1)$$

In other words, a patch of slip inhibits further slip in a zone of thickness d on each side by annihilating the stress there, and we have to expect that the minimum spacing of slip bands at the stress σ will be d, as given by equation 1.

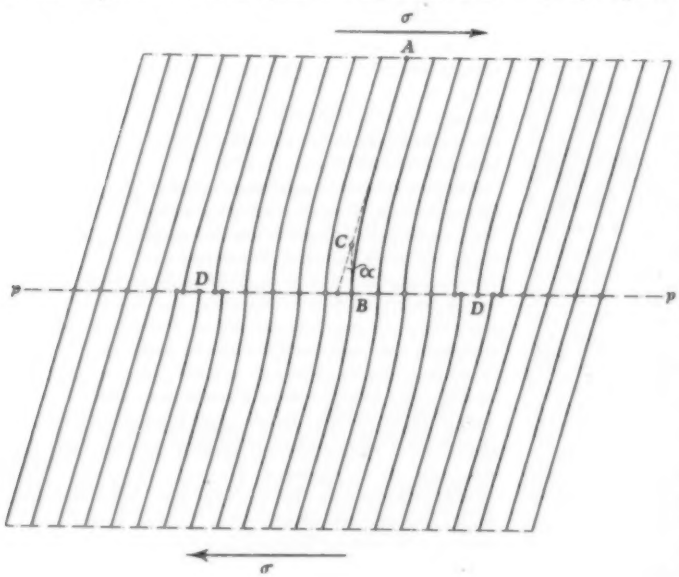
A better approximation for d may be obtained by calculating the minimum stress which makes two dislocations (the edges of the slipped patches), situated in slip planes the distance between which is d, move past each other. For the special case of parallel straight lines of dislocation, this calculation has already been done by G. I. Taylor[1], with the result

$$\sigma/d = 1/2\pi.Ga \qquad (2)$$

which differs from (1) only by the factor $1/\pi$.

The best-known example of very regular slip bands is that observed by Straumanis[2] on small crystals of zinc grown from vapour. The glide strain was, according to the micro-photographs, about 50–60 per cent; the corresponding resolved shear stress[3] is about 160 gm./mm.^{2}. With $G = 4{\cdot}08 \times 10^6$ gm./mm.^{2} and $a = 2{\cdot}66 \times 10^{-7}$ mm., equation 2 gives $d = 1{\cdot}1\mu$; the mean value of d, as observed by Straumanis, was $0{\cdot}8\,a$.

For different crystals, the stresses needed for plastic deformation generally increase with increasing G, so that the values of G/σ vary within comparatively narrow limits. This explains why the observed spacings of slip bands are usually



of the order 10^{-4} cm., a value obtained from (1) or (2) by substituting typical values for G, σ, and a.

According to (1) or (2), the spacing of slip bands should be inversely proportional to the shear stress, except in the first stage of the deformation, when the bands are not close enough to influence each other. This has, in fact, been observed by Yamaguchi[4] on extended aluminium crystals. The product $\sigma.d$, calculated from the measurements of Yamaguchi, has values between 4·9 and 8·7 gm./mm., while (1) gives 0·35 and (2), 0·12. This is probably due to the fact that the slip bands on Yamaguchi's crystals did not extend over the full circumference of the crystal, but consisted of an echelon-like pattern of short overlapping lines, and their number was determined by counting the bands which intersected a perpendicular straight line of unit length.

According to the derivation of (1), the spacing of the slip bands directly reflects the atomic structure of the material; from the spacing of the slip bands and the corresponding stress an estimate of the atomic distance a could be obtained.

An estimate of the molecular shear strength σ_m is given by the formula[5]

$$\sigma_m.b = 1/2\pi.Ga, \qquad (3)$$

where b is the spacing of the lattice planes parallel to the plane of slip. Comparison with (2) shows that the spacing of slip planes is the spacing of the parallel lattice planes, enlarged in the proportion of the molecular shear strength to the actual shear stress.

(1) or (2) may prove of great usefulness for calculating, from the spacing of slip bands, the true internal stresses in individual grains and at grain boundaries in deformed polycrystalline materials. So far these stresses have been inaccessible to measurement.

With a relationship like (1) or (2), the problem of work hardening and creep in a crystal containing an unknown number of active slip planes is reduced to that of work hardening and creep in single slip bands. Together with a new experimental method for the direct measurement of the distribution of slip over the crystal, recently worked out in this Laboratory[6], this should open the way for the solution of the fundamental problem of plastic gliding, the determination of the number of lattice planes actively involved in the deformation.

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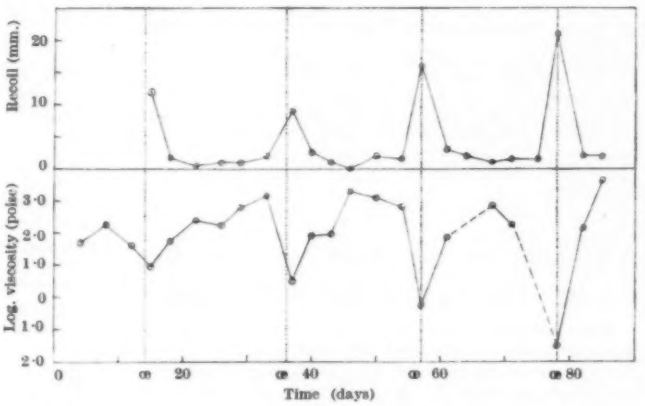
March 5.

[1] Taylor, G. I., *Proc. Roy. Soc.*, A, **145**, 379 (1934), first line from top.
[2] Straumanis, *Z. Krist.*, **83**, 29 (1932).
[3] Schmid, E., and Boas, W., "Kristallplastizität (Berlin, 1935), Fig. 124*b*.
[4] Yamaguchi, K., *Sci. Pap. Inst. Phys. Chem. Res.*, Tokyo, **8**, 289 (1928).
[5] Orowan, E., *Proc. Phys. Soc.*, **52**, 8 (1940).
[6] To be published shortly.

Rheological Properties of Bovine Cervical Secretions during the Œstrous Cycle

THE secretions of the cervix of the cow in different reproductive phases have been described by Woodman and Hammond[1] and Hammond[2]. In œstrus, the mucus in the cervix and upper vagina is plentiful and fairly fluid, while in mid-cycle it is greatly diminished in amount and is more viscous. The characteristic stickiness of pregnant secretions has been proposed as a rough test for pregnancy (Marshall and Hammond[3]).

We are making a quantitative study of certain rheological properties of these secretions, which, although not true fluids, give approximately linear flow-curves in a Scott Blair emptying-capillary viscometer[4], doubtless owing to a convenient cancellation of opposite curvatures. The viscosities vary over such a wide range (order 70,000 : 1) during the œstrous cycle, that any reproducible viscosity figure is satisfactory.



Since in this instrument the rate of emptying under constant pressure of an initially full capillary is measured, the linearity of the flow-curves indicates that there must be a marked work-hardening of the material compensating for the known fall in viscosity produced by rising shearing force per unit area. This work-hardening is accompanied by a very large 'flow-elasticity'[5] in the case of œstrous samples, which can be measured in terms of the recoil of the meniscus in the capillary when pressure is suddenly released. The œstrous samples are also remarkably 'spinnbar'[6]. Hammond[2] had already noted the 'stringy' nature of œstrous secretions.

The figure shows the viscosities (plotted logarithmically) and the recoil in mm. for one cow during several œstrous cycles, dotted lines indicating œstrus as observed by the herdsman. Similar effects for a number of other animals have been observed.

Since the flow-elasticity alone gives a clear indication of œstrus and can be determined much more rapidly than can the viscosity, a simple apparatus has been designed ('œstroscope') for use in the cowshed, in which a 5 ml. hypodermic syringe is attached to a narrow glass tube (diam. 2 mm., length 10 cm.) which is filled with secretion by suction. The tube is slowly emptied by pressure on the plunger at a steady rate of about 5 mm./sec., a side-tube closed

with the thumb serving as a means of releasing the pressure sharply. The recoil of the meniscus is measured on a millimetre scale.

The secretion samples, which are taken by hand from the neighbourhood of the cervix in the upper vagina, are best homogenized before use in the viscometer or œstroscope by squeezing several times between two glass plates. It is hoped that this technique will serve as an indication and a means for the prediction of œstrus in cows. Further work on samples from pregnant cows is in progress.

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March 11.

[1] Woodman, H. E., and Hammond, J., *J. Agric. Sci.*, **15**, 107 (1925).
[2] Hammond, J., "Reproduction in the Cow" (Camb. Univ. Press, 1927).
[3] Marshall, F. H. A., and Hammond, J., "Fertility and Animal Breeding", Bull. Min. Agric. and Fish. No. 39 (1937).
[4] Scott Blair, G. W., *Koll. Z.*, **78**, 19 (1937).
[5] Szegvari, A., *Z. Phys. Chem.*, **108**, 175 (1924); Ostwald Wo. and Malss, H., *Koll. Z.*, **63**, 305 (1934); *ibid.*, **67**, 219.
[6] Erbring, H., *Koll. Beih.*, **44**, 171 (1936), etc.

Sensitivity of the Dark-adapted Eye during a Prolonged Period of Observation

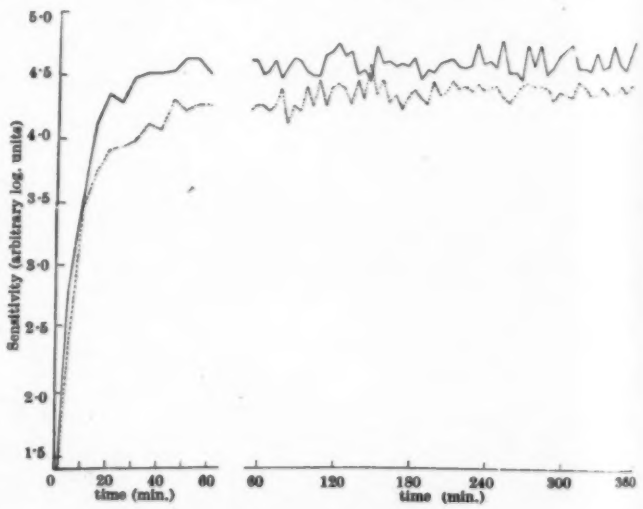
Two related problems of dark adaptation which have important practical applications, but which have received little or no attention, are (1) whether maximum sensitivity, once attained, will last more or less indefinitely, and (2) whether the course of adaptation is affected by fatigue. The experiments here described were carried out to obtain information on the second point, and if the results proved negative, on the first as well.

Observations on the absolute threshold for light intensity during the process of dark adaptation were made by means of Nagel's adaptometer[1], the technique being that described by me elsewhere[2]. Readings were taken following 10 minutes preliminary light adaptation, at intervals of 5 minutes throughout two sessions of 6 hours each, two weeks elapsing between the sessions. I, having participated as subject or experimenter in about seventy experimental dark adaptation sessions, acted as subject. The sessions here described took place following an ordinary day's activity (teaching, research, etc.), ending with 3 hours fire-watching duties, the exact times being 10 p.m.–4 a.m. on the first occasion, and 10.30 p.m.–4.30 a.m. on the second. During the session some black coffee and plain biscuits were taken. (The vitamin A content of these was negligible, and no observable effect on the readings was produced.) I experienced the usual signs of sleepiness, but no acute discomfort.

On the first occasion adaptation was carried out in complete darkness, in the ordinary way. On the second, it was carried out during continuous stimulation with diffused red light, as described in reference[2]. The light was bright enough to read by, though not with ease. The results of both sessions are shown in Fig. 1 and the accompanying table. The ordinates on the curves in Fig. 1 are a measure of sensitivity in arbitrary logarithmic units, corresponding to the reciprocal of threshold intensity at the time of each reading, and representing successive logarithmic steps below the maximum intensity of the adaptometer light. The figures in the table show mean sensitivity measures during each successive hour of the session. From the dispersions of these (as well as by observing the course of the curves) an indication of fluctuation or variability may be obtained. It will be seen that there is a slight upward tendency in both curves throughout the test period, there being in each case only one hour showing a mean reading lower than

	Adaptation during darkness			Adaptation with red light		
1	2	3	4	2	3	4
1	4·245	*		3·895	*	
2	4·612	0·0171	+0·367	4·329	0·0196	+0·434
3	4·625	0·0148	+0·013	4·397	0·0195	+0·068
4	4·614	0·0130	−0·009	4·411	0·0107	+0·014
5	4·638	0·0218	+0·013	4·397	0·0101	−0·014
6	4·648	0·0175	+0·010	4·407	0·0078	+0·010

1. Hour of observations. 2. Mean sensitivity during hour. 3. P.E. mean. 4. Increase or decrease over previous hour. * Readings during first hour show normal expected rise, hence their dispersion is meaningless.



COURSE OF DARK ADAPTATION
——— during darkness (initial reading 0·85);
..... with red light stimulation (initial reading 0·94).

N.B. Curves in two portions, with 10 minutes overlap common to both; time scale in second part one-half that of first.

that for the previous hour. These differences, however, are not statistically significant, the probable errors of these differences (not here noted) being in many cases greater than the differences themselves.

The following conclusions can be drawn :

(1) Maximum dark adaptation may be maintained for at least as long as 6 hours. That no falling-off occurs is in accordance with the assumptions or findings (over shorter periods) of most experimenters[3].

(2) The almost complete adaptation previously[2] noted during stimulation with red light can also be maintained over this test period.

(3) Ordinary fatigue at the end of a normal day's sedentary work has no effect on the adaptation process, as measured by the maximum 'level' attained. Nor is the accuracy of observation, as shown by the dispersion of the readings during successive periods, affected. In fact, in the second of the sessions here described, variability became progressively less.

In short, results obtained with a single practised subject suggest that it is possible, at least for some individuals, to maintain accurate observation in the dark-adapted state during a protracted period of enforced wakefulness.

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March 5.

[1] Nagel, W. A., *Z. Augenhk.*, 17, 201–216 (1907).
[2] In an article to be published in the *Brit. J. Psychol.*
[3] With a few exceptions, notably Kravkov and Semenovskaja, in "Visual Sensation and Perception" (State Psychol. Inst., Moscow,) 138–152 (1935).

Relation between Colour and Permeability of Insect Cuticles

THE same chemical process has been shown by Fraenkel and Rudall[1], Pryor[2], and others, to be responsible for the darkening and the hardening of insect cuticles. Hence the physical properties of the cuticle in light and dark varieties of the same species may be expected to differ. Yellow mutants of *Drosophila pseudo-obscura* and *subobscura*, and less markedly of *D. melanogaster* and *simulans*, lost weight in a dry atmosphere more rapidly than the wild type, whether they were alive or dead, and the dead yellow mutants regained weight more rapidly after drying. The yellow mutants died more rapidly in a dry atmosphere. Similarly the black and ebony mutants of *D. melanogaster* lost water more slowly than the wild type, and survived longer in a dry atmosphere.

The bearing of these results, which will be published in full elsewhere, on the selective advantage of melanism in insects, is obvious. In particular they may account for the surprising frequency, noted by Buxton[3], of black insects in deserts.

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[1] *Proc. Roy. Soc.*, B, **128**, 378–407 (1940).
[2] *Proc. Roy. Soc.*, B, **129**, 1–35 (1940).
[3] "Animal Life in Deserts", London (1923).

Early Exploration of Kent's Cavern

IN amplification of the biographical note on the Rev. J. MacEnery in NATURE of February 15, p. 202, it may be noted that a demy octavo edition of "Cavern Researches", etc., edited from the original manuscript notes by E. Vivian, was published in 1859. According to the preface to this issue, MacEnery was compelled, after a second appeal, to abandon the project of publishing his researches owing to lack of adequate financial support. Indeed, as MacEnery acknowledges the help he had received in his excavations from several clergymen, including the then Bishop of Bath and Wells, it is unlikely that fear of ecclesiastical censure had anything to do with his decision to refrain from publication.

At the sale of MacEnery's effects a Mr. Lear of Lawrence Place purchased a lot of sermon notes among which, after many years, the above manuscript was accidentally discovered by Vivian, who published extracts from it in the *Torquay Directory*. Afterwards the manuscript was bought by a Mr. W. Long who gave it to Vivian with a view to publication. The notes were in a very rough state but they were rearranged by their editor "as far as practicable in a connected series" without any additions ; the notes on Berry Head cavern were missing.

A large paper edition is stated to have been published, illustrated by sixteen plates which had been previously executed at the expense of the Very Rev. Wm. Buckland, Dean of Westminster.

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THE large paper edition of "Cavern Researches", which is a quarto volume with seventeen plates, and the smaller demy octavo, are in the Library of the Torquay Natural History Society. The former volume has twenty-five pages of letterpress and the latter seventy-eight pages.

The larger volume was published by E. Vivian in 1859, who in the preface mentions that the profits of that edition would be placed at the disposal of the Society, and as the seventeen plates were all executed in his life-time it does not appear that Mr. MacEnery would have been put to much expense in having the work published. His patrons, the wealthy family of Cary of Tor Abbey, surely would have helped their chaplain of nineteen years service had they been sure of his ecclesiastical position if he had required merely their financial assistance, but it is not at all unlikely that as he was a Roman Catholic he would have found it difficult to secure an 'Imprimatur'.

Harford J. Lowe, honorary secretary of the Torquay Natural History Society, in vol. 3 of the Society's *Journal* writes : "Circumstances combined with the want of encouragement and help from the representatives and guardians of his science frustrated his design, while there was also, no doubt, some apprehension of the new facts seriously affecting some of the traditional foundations of the 'Faith' . . . He shrank from such responsibility which ill-health would make appear greater and more serious, and so his sense of duty to Science was outweighed by his doubts and fears respecting its public use and benefit".

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LANDMARKS IN CHEMOTHERAPY

THE forty-ninth Bedson Lecture was delivered by Prof. C. H. Browning at King's College, Newcastle-upon-Tyne, on March 11, the subject being "Landmarks in Chemotherapy". After defining chemotherapy and summarizing its position in 1900, Prof. Browning traced the search for synthetic compounds with curative action in infections due to trypanosomes, spirochaetes, malarial parasites and bacteria. The first great advance was the discovery of trypan red, with which Ehrlich and Shiga (1904) cured a surely fatal infection due to certain trypanosomes in mice. It had the disadvantage of staining the body tissues and was of little practical value; but it led to Bayer-205, a colourless symmetrically substituted urea derivative. In the case of the latter the ratio of the maximum tolerated to the minimum curative dose is very large; any change, however slight, in its molecular structure causes a great diminution in its activity. It is the most effective drug for the cure of the African forms of human trypanosomiasis, provided that treatment is begun early. About the same time as the discovery of trypan red, the organic arsenical atoxyl was shown by Thomas at Liverpool to be active against trypanosomes *in vivo*. Although inactive *in vitro*, it becomes active in the test tube on reduction to the trivalent arsenic state. Therefore it seems that the drug is reduced in the body or even inside the trypanosome itself. The outcome of the investigation of arsenicals in Ehrlich's laboratory was salvarsan and its derivative neosalvarsan. The latter, especially from convenience in use, has come to be the most important drug in the treatment of syphilis.

For the treatment of malaria, in addition to quinine, Ehrlich and Guttmann in 1891 found methylene blue to be active in the quartan variety. In 1926 Roehl showed that a quinoline derivative, plasmoquine, was effective; it destroyed the sexual stage or crescent of the tropical variety, which is resistant to other drugs. Schulemann (1932) introduced atebrin, an acridine derivative which, like quinine, acts on the asexual stage. It is noteworthy that both these synthetic anti-malarial drugs possess the same sidechain—$NH.CH(CH_3).(CH_2)_3.N(C_2H_5)_2$—although they differ in the stage of the parasite which is attacked.

Scientific attempts to destroy bacteria in the tissues date from 1867, when Lister experimented with some success on the use of crude carbolic acid in the treatment of compound fractures. This was an example of the application of a 'surface' antiseptic which could be brought into intimate contact with an infected site.

Up to about 1914 it was believed that an antiseptic must be a general protoplasm poison, harmful alike to the bacteria and the infected host. But this idea was disproved by observations with the newer antiseptics, such as acriflavine and proflavine. An example is afforded by Blake's experiments on trout ova infected with *B. salmonicida*; although carbolic acid is almost equally toxic to both, a concentration of 1 : 2,000 acriflavine will kill the bacteria without appreciably damaging the ova. Experimental streptococcal infections have also been successfully treated with acriflavine as well as certain quinoline compounds of the Schiff's base type (anils), the method being to inject the organisms into the abdominal cavity and then after an interval to follow up with a solution of the drug. Such antiseptics are valuable for the treatment of local infections of wounds, especially as preventives.

As regards the treatment of general bacterial infections, in 1911 Morgenroth and Levy showed ethylhydrocupreine (optoquine) to be active against experimental pneumococcal infection in mice; this observation was of scientific interest only. The first compounds of practical value were the azo dyes derived from *p*-aminobenzene sulphonamide, used by Domagk, such as "prontosil soluble". Tréfouel *et al.* showed that it is the sulphonamide part of the molecule which is effective, and that the removal of the part linked by the azo grouping does not cause loss of activity. Sulphanilamide itself is fairly soluble and rapidly absorbed and excreted. Analogues, such as sulphapyridine, which have proved very useful clinically, are much less soluble and more slowly absorbed, so tending to maintain a more continuous action. Compounds of this class which are effective against streptococci in experimental infections, may fail with staphylococci.

While these drugs have revolutionized the treatment of meningococcal meningitis and gonococcal infections, and have profoundly modified the course of pneumonia, they appear to have little effect on some other infections, for example, tuberculosis.

CONTROL OF TRANSPORT IN GREAT BRITAIN

WHILE Lord Stamp and his fellow chairmen of the four great railway companies in Great Britain have made spirited replies to some of the criticism levelled at the railways in recent months, rail transport is only one aspect of a problem which has aroused widespread concern. The importance of transport in war has been well brought home to us in recent months by the measures designed to save shipping space, and the severity of the attacks on British and Allied shipping. It is only in a limited sense, however, that we have learnt that the power to transport may be the decisive factor, although its bearing on our blockade of Germany has been indicated by Dr. Hugh Dalton. That blockade can only be decisive if transport difficulties, intensified by bombing, reduce the enemy's supplies in his vast territories below what Dr. Dalton calls the 'distributional minimum'. We have yet to appreciate as a nation that the transport problem is a simple problem, and must be governed by national, not by commercial, considerations. The transport services in Great Britain must make their utmost contribution to the war effort without regard to other considerations.

This argument is the basis of Bulletin No. 5, "The Organisation of Transport for War", issued by the Vigilance-for-Victory Group (10 Hertford Street, London, W.1). It recognizes that some of the progressive slow-down of transport has been due to conditions directly imposed by the War, and that the transport services have done their best to overcome their formidable difficulties within the limits imposed by the nature of the transport service. While, however, it is of the utmost importance from the point of view of national defence that our internal lines of communication shall be organized and operated at the highest efficiency, there has been a falling off in efficiency which has substantially reduced the capacity of the transport services. Moreover, the system of internal communications must be considered as a whole. The greatest efforts of the most experienced officers with purely local functions can be frustrated by action in distant parts of the country without anyone being able to relate cause to effect. Failure to combine the highest professional experience with power and responsibility is the root cause of the situation which the recent appointments of two regional port directors are intended to correct.

The bulletin makes the point that transport difficulties are due to failure to co-ordinate transport supply with transport demand on a properly planned and organized basis, as was indeed indicated in Lord Stamp's address. Our present lines of communication are unnecessarily complicated because they have in the main been built up around, or in competition with, a method of railway operating, which however inevitable in the past, is no longer so, and is in itself complex. Statistics of the Ministry of Transport show the very low efficiency of railway operation and serious under-employment of equipment, and this is due to the methods of operating and the very low speed of movement. The delay in clearing ports and distributing supplies, even before mass air-attacks, was due to lack of ways, not of means. There appears to be no real shortage of equipment. The prime cause of the absence of organization is the persistent assessment of transport operations by their financial results and not by their service to national requirements.

The bulletin accordingly proposes that for the organization of our lines of communication for war purposes, the present advisory committee or consultative committees of the Minister of Transport should be abolished and replaced by a Transport Executive Council. Composed of professional transport officers of skill and experience, who would become full-time servants of the State, and functioning very much as the Board of Admiralty and the Army Council or the Air Council, this Council would handle the management and planning of transport services as a whole and decide the broad policy and major problems. The Minister of Transport would be president of the Council, which would directly control all forms of transport, each member of the Council being responsible for a group of departments. Regional organization would also be a matter for the Minister and the Transport Executive Council. While the precise form of regional organization would depend largely on the policy adopted to co-ordinate different forms of transport, it is probable that the simplest and most direct form of control would be through regional transport executive officers, who would exercise full authority over all forms of transport.

The War Transport Council just set up by the Minister of Transport would appear to be a step in the direction envisaged by the "Vigilance-for-Victory" Group.

HUMUS FROM HABITATION WASTES

By Prof. R. H. Stoughton,
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THE disposal of the waste materials incident to the existence of mankind has always been one of the major problems of any large civilization. Primitive man, leading a nomadic existence, left his waste wherever he might be. As community living developed, the midden became more and more a necessary part of living conditions, and when towns grew the disposal of waste products began to assume the proportions of a real difficulty. The value of animal and human excreta for the improvement of the soil and for plant growth was discovered by many races; the possibility of returning decomposed garbage to the soil similarly seems to have been thought of at many times in history; the combination of the two appears, however, only to have been practised in early times by the Chinese.

Western civilization developed the disposal of refuse, first by dumping and later by incineration; millions of tons of organic matter are, in one or other of these ways, destroyed at the present time. The wasteful disposal of excreta was later in coming. Until the advent of water-borne sewerage, night-soil still went back to the land, and a great deal of the nitrogen taken from the soil by plants was returned to it in this way. Then came modern systems of sewage disposal and all this 'went down the drain'. But water-borne sewerage, though bringing hygiene and health, brought also new problems of disposal, and thousands of tons of sludge containing only about five per cent or less of solid matter accumulate at every sewage works, and must be got rid of, either by dumping in the sea or by slow drying on extensive beds.

In the meantime our soil is crying out for organic matter. Without organic matter a soil is 'hungry'; its moisture content, the essential key to plant growth, fluctuates wildly with the rainfall, and with its water its soluble mineral content varies. The agriculturist and horticulturist, recognizing the need for organic matter, have for centuries used dung and green manure as the source. Now the supply of animal manures is growing less every year; surely it is time something was done to stop the destruction of all the organic matter in habitation wastes and to convert them into a form suitable for restoring the organic content of the soil.

Lieut.-Colonel F. C. Temple in a recent paper[1] discussed these difficulties and outlined the attempts which have been made to solve the problem of the economic utilization of these waste materials. The

Indore process of which so much has been heard is one such method though, in itself, it contains nothing original; it does not, in any event, deal with the problem of sewage sludge, but is concerned with the combination of vegetable wastes with night-soil and animal excreta. A process is, however, actually being worked at Maidenhead and Leatherhead whereby screened dust-bin refuse, which as it stands is too dry to compost, is used primarily as an absorbent of sewage sludge, which is too wet, and the two together are composted to give a product rich in organic matter and capable, in the soil, of being converted to that ill-understood complex which we term 'humus'. Colonel Temple made out a strong case for an extension of this kind of work, and pleaded for experimentation and a wider vision by municipal authorities. The discussion on the paper showed a sharp cleavage between those who, recognizing the great potential value of such products, wanted to see work directed to improvement and standardization of methods, and those who considered the problem already solved and wished for immediate installation of plant by municipalities.

The Agricultural Research Council, realizing the need for knowledge of what happens when these materials are brought together, has recently financed an investigation at the University of Reading on the preparation of such composts. Such points as the attainment of a correct carbon-nitrogen ratio for satisfactory fermentation, the influence of varying proportions of the two primary components and the proper balance between aerobic and anaerobic decomposition are under study. The problems presented are innumerable; the potentialities are so great as would justify the creation of a research centre for this kind of work alone.

One thing is clear, the product to be manufactured must be 'safe'; that is, it must be so far decomposed that when it is added to the soil, immobilization of nitrogen through diversion of the activities of soil bacteria must not occur, and the carrying-over of pathogenic organisms in the compost must be rendered impossible. The farmer must have no doubts about the materials; once such a product can be made with certainty, a new era in the disposal of habitation wastes will begin.

[1] "Municipal Manufacture of Humus from Habitation Wastes". Paper read at a meeting of the Royal Society of Arts on January 29, 1941, by Lieut.-Col. F. C. Temple (*J. Roy. Soc. Arts*, **84**, 215–228; 1941).

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Abstracts of Patents relating to Rubber Latex. By T. R. Dawson and R. W. Parris. (A Supplement to "Rubber Latex".) Pp. v+136. (London: British Rubber Publicity Association.) Free. [193

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Industrial Research Bureau. Bulletin No. 17: The Manufacture of China Glass. By Dr. Atma Ram and Dr. Lal C. Verman. Pp. iv+10. 5 annas; 6d. Bulletin No. 18: Utilization of Indian Vegetable Oils as Lubricants in Internal Combustion Engines, Part 1. By Jogi Sarup Aggarwal and Dr. Lal C. Verman. Pp. 25. 9 annas; 10d. (Delhi: Manager of Publications.) [93

Brooklyn Botanic Garden Record. Vol. 30, No. 1: List of Shrubs, exclusive of Conifers, growing Outdoors in the Brooklyn Botanic Garden, 1940. (Guide No. 11.) Pp. 35. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) 25 cents. [93

Smithsonian Miscellaneous Collections. Vol. 99, No. 10: Coelenterates collected on the Presidential Cruise of 1938. By Elizabeth Deichmann. (Publication 3595.) Pp. ii+17+1 plate. (Washington, D.C.: Smithsonian Institution.) [73

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U.S. Department of Agriculture. Circular No. 576: The Use of Chlorine Gas as a Seed Disinfectant. By R. W. Leukel and O. A. Nelson. Pp. 16. 5 cents. Leaflet No. 205: The Horn Fly and its Control. By W. P. Bruce. Pp. 6. 5 cents. (Washington, D.C.: Government Printing Office.) [113

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The Book of Dunns Farm Seeds, 1941. Pp. 28. (Salisbury: Dunns Farm Seeds, Ltd.)

Gentian Violet Jelly B.D.H. Pp. 2. (London: The British Drug Houses, Ltd.)

Your Camera Lens. Pp. 24. (Birmingham: Aldis Brothers, Ltd.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT PROFESSOR IN THE DEPARTMENT OF GLASS TECHNOLOGY—The Registrar, The University, Sheffield (April 18).

DIRECTOR OF EDUCATION for the County Borough of Derby—The Director of Education, Education Office, Becket Street, Derby (April 18).

GRADUATE ASSISTANT TO TEACH MATHEMATICS AND GENERAL SCIENCE SUBJECTS, and a GRADUATE ASSISTANT TO TEACH MECHANICAL ENGINEERING SUBJECTS at the West Hartlepool Technical College—The Chief Education Officer, Education Offices, Park Road, West Hartlepool (April 19).

ASSISTANT ENGINEER for the Federated Malay States Government Railways—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9618).

WOMAN LECTURER TO ASSIST IN BIOLOGY AND HYGIENE—The Principal, Edge Hill Training College, at Bingley, Yorks.